

MANUAL DE ESPECIFICACIONES TÉCNICAS

TEATRO AL AIRE LIBRE

*NUEVAS FACILIDADES AL EXTERIOR PARA EL
CENTRO DE BELLAS ARTES LUIS A. FERRÉ*

22 ½ Avenida Ponce de León
San Juan, Puerto Rico

PROFESSIONALS OF RECORD:

JORGE RIGAU, FAIA
ARCHITECT

JOAQUÍN DE MARI, PE
STRUCTURAL

CARLOS J. REQUENA DÁVILA, PE
ELECTRICAL

FRANCISCO MATÉ, PE
MECHANICAL



JORGE RIGAU FAIA **ARQUITECTOS PSC**
MARCH, 2023


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SECTION 000101 - PROJECT TITLE PAGE

PART 1 - GENERAL

1.1 PROJECT MANUAL

- A. VOLUME PBA
- B. Teatro al Aire Libre.
- C. Jetpphet Pérez de Corcho Morgado.
- D. San Juan, Puerto Rico.
- E. Architect Project No. TBA-23.
- F.  JORGE RIGAU FAIA **ARQUITECTOS PSC**
- G. Jorge Rigau Arquitectos PSC.
- H. Urb. Hyde Park, 855 ave. Las Marías.
- I. San Juan, Puerto Rico, 00927.
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- L. Issued: March 15, 2023.
- M. Copyright Jorge Rigau Arquitectos PSC. All rights reserved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 000101

DOCUMENT 000107 - SEALS PAGE

PART 1 - GENERAL

1.1 DESIGN PROFESSIONALS OF RECORD

- A. Architect:
 - 1. Jorge Rigau.
 - 2. **#7650.**
 - 3. Responsible for Divisions #01-#33 Sections except where indicated as prepared by other design professionals of record.
- B. Structural Engineer:
 - 1. Joaquin De Mari.
 - 2. **Lic. #21268.**
 - 3. Responsible for Divisions #03 & 05.
- C. Plumbing & Mechanical Engineer:
 - 1. Francisco Maté.
 - 2. **Lic. #13947.**
 - 3. Responsible for Division #22.
- D. Electrical Engineer:
 - 1. Carlos Requena.
 - 2. **Lic. #19722.**
 - 3. Responsible for Division #26.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 000107

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

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26 56 19 LED EXTERIOR LIGHTING

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DOCUMENT 000115 - LIST OF DRAWING SHEETS

PART 1 - GENERAL

1.1 LIST OF DRAWINGS

- A. Drawings: Drawings consist of the Contract Drawings and other drawings listed on the Table of Contents page of the separately bound drawing set titled 100% Documentos de Construcción, dated March 15, 2023, as modified by subsequent Addenda and Contract modifications.
- B. List of Drawings: Drawings consist of the following Contract Drawings and other drawings of type indicated:
 - 1. A-100 / HOJA TÍTULO.
 - 2. A-101 / VISUALIZACIONES 3D
 - 3. A-102 / NOTAS GENERALES, SÍMBOLOS & ABREVIACIONES

4. A-103 / PLANTA DE TECHO
5. A-104 / PLANTA
6. A-105 / DETALLES AMPLIADOS-ESCENARIO
7. A-106 / PLAFÓN REFLEJADO
8. A-107 / PLAFÓN-A
9. A-108 / PLAFÓN-B
10. A-109 / PLAFÓN-C
11. A-110 / ALZADOS ESTE Y OESTE
12. A-111 / ALZADOS NORTE Y SUR
13. A-112 / SECCIONES A, B, C & D
14. A-113 / SECCIONES E, F, & G
15. A-114 / ALZADOS INTERIORES
16. A-115 / AMPLIACIÓN DE CAMERINO Y EQUIPOS DE BAÑOS
17. A-116 / PUERTAS Y VENTANAS
18. A-117 / TERMINACIONES Y DETALLES TÍPICOS
19. S-100 / FOUNDATION AND STRUCTURAL ROOF PLAN
20. S-101 / FRAME FOUNDATION PLAN
21. S-102 / STRUCTURAL AND UPPER ROOF PLAN
22. S-200 / SECTIONS
23. S-300 / SECTIONS
24. SN-1 / STRUCTURAL NOTES
25. SN-2 / GENERAL DETAILS
26. AC-1 / AIR CONDITIONING
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33. E-03 / PANEL SCHEDULES LEGEND AND NOTES

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work performed by Owner.
5. Multiple Work Packages.
6. Work under Owner's separate contracts.
7. Future work not part of this Project.
8. Owner's product purchase contracts.
9. Owner-furnished/Contractor-installed (OFICI) products.
10. Owner-furnished/Owner-installed (OFOI) products.
11. Contractor-furnished/Owner-installed (CFOI) products.
12. Contractor's use of site and premises.
13. Coordination with occupants.
14. Work restrictions.
15. Specification and Drawing conventions.
16. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 017300 "Execution" for coordination of Owner-installed products.

1.2 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.3 PROJECT INFORMATION

- A. Project Identification: Teatro al Aire Libre, Centro de Bellas Artes Luis A. Ferré.
1. Project Location: 22 ½ Avenida Ponce de León
San Juan, Puerto Rico
.
- B. Owner: Corporación Centro de Bellas Artes.
1. Owner's Representative: Jetpehlt Pérez de Corcho Morgado.

- C. Architect: Jorge Rigau Arquitectos P.S.C.
1. Architect's Representative: Alexander Esparolini, CAAPPR.
- D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:
1. Structural Engineer: JCDM Structural Engineering.
- a. Structural Representative: Joaquin de Mari.
- E. Other Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
1. **<Insert title of design discipline>: <Insert name for consultant firm>** has prepared the following portions of the Contract Documents:
- a. **<Insert title of design discipline> Representative: <Insert name and contact information of Owner consultant representative>.**
- b. **Scope of Service: <Insert description of scope of service for Owner consultant>.**
- F. Contractor: **<Insert name of Contractor firm>** has been engaged as Contractor for this Project.
1. Contractor Representative: **<Insert name and contact information for Contractor representative>.**
- G. Construction Manager: **<Insert name of Construction Manager firm>.**
1. Construction Manager Representative: **<Insert name and contact information for Construction Manager representative>.**
2. Construction Manager has been engaged for this Project to serve as an advisor to Owner and to provide assistance in administering the Contract for construction between Owner and [each] Contractor, according to a separate contract between Owner and Construction Manager.
- a. Construction Manager also serves as Project coordinator, as defined in Section 011200 "Multiple Contract Summary."
3. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- H. Design-Builder: **<Insert name of design-builder firm>.**
1. Design-Builder Representative: **<Insert name and contact information for design-builder representative>.**
2. Design-builder has been engaged for this Project to provide architectural and engineering services and to serve as Project's constructor. The terms "design-builder" and "Contractor" are synonymous.
- I. Project Coordinator for Multiple Contracts: **<Insert name and contact information of Project coordinator>** has been engaged by Owner to serve as Project coordinator.
- J. Project Coordinator for Multiple Contracts: Owner shall serve as Project coordinator.
- K. Project Mechanical/Electrical Coordinator for Multiple Contracts:

1. <Insert name and contact information of mechanical/electrical Project coordinator> has been engaged by Owner to serve as Project coordinator.
 2. [HVAC Contractor] [Electrical Contractor] [Plumbing Contractor] [Construction Manager] <Insert entity> shall act as mechanical/electrical coordinator.
- L. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.
1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
1. <Insert a brief description of Project indicating the size, code classification for occupancy and construction type, and general description of major building assemblies> and other Work indicated in the Contract Documents.
- B. Type of Contract:
1. Project will be constructed under a single prime contract.
 2. Project will be constructed under coordinated, concurrent multiple contracts. See Section 011200 "Multiple Contract Summary" for a list of multiple contracts, a description of work included under each of the multiple contracts, and the responsibilities of Project coordinator.

1.5 PHASED CONSTRUCTION

- A. Construct the Work in phases, with each phase substantially complete as indicated [on Drawings] [below].
1. Phase <Insert designation>: <Briefly describe work of this phase>.
 - a. Commencement of Construction:
 - 1) Notice to Proceed: Work of this phase shall commence within <Insert number of days> after the Notice to Proceed.
 - 2) Start Date: Work of this phase shall commence by <Insert date>.
 - b. Substantial Completion:
 - 1) Within <Insert number of days> after [commencement of construction of this phase] [after the Notice to Proceed].
 - 2) By <Insert date>.
 2. Phase <Insert designation>: Perform the remaining Work. The remaining Work shall be substantially complete at time of Substantial Completion of the Work.
- B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule, showing the sequence, commencement and completion dates[, and move-out and -in dates of Owner's personnel] for all phases of the Work.

1.6 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.
 - 1. <Insert a brief description of work performed by Owner>.
- C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
 - 1. <Insert a brief description of work performed by Owner>.
- D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
 - 1. <Insert a brief description of work performed by Owner>.

1.7 MULTIPLE WORK PACKAGES

- A. Construction Documents for this Project will be issued in a series of Work Packages, each defining the Work under individual Contracts. Coordinate the Work under this Contract with separate contracts defined by other work packages. **[Work Packages consist of the following:]**
 - 1. [Early Site Package] <Insert Work Package title>: <Insert description of Work>. To be issued <Insert date of anticipated issue>.
 - 2. [Foundations and Structure Package] <Insert Work Package title>: <Insert description of Work>. To be issued <Insert date of anticipated issue>.
 - 3. [General Building Package] <Insert Work Package title>: <Insert description of Work>. To be issued <Insert date of anticipated issue>.
 - 4. [Interior Upfit Package] <Insert Work Package title>: <Insert description of Work>. To be issued <Insert date of anticipated issue>.

1.8 WORK UNDER OWNER'S SEPARATE CONTRACTS

- A. Work with Separate Contractors: Cooperate fully with Owner's separate contractors, so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under Owner's separate contracts.
- B. Preceding Work: Owner [has awarded] [or] [will award] separate contract(s) for the following construction operations at Project site. Those operations [are scheduled to be substantially complete before Work under this Contract begins] [may be substantially complete or may be partially conducted simultaneously with Work under this Contract].
 - 1. <Insert name of the Contract>: To <Insert name of Owner's separate Contractor> [to] [for] <Insert a brief description of work performed under Owner's separate contract>.

- C. Concurrent Work: Owner **[has awarded]** **[will award]** **[and will assign to Contractor]** separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
1. **<Insert name of the Contract>: To <Insert name of Owner's separate Contractor> [to] [for] <Insert a brief description of work performed under Owner's separate contract>.**
- D. Subsequent Work: Owner **[has awarded]** **[will award]** separate contract(s) for the following additional work to be performed at site following Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
1. **<Insert name of the Contract>: To <Insert name of Owner's separate Contractor> [to] [for] <Insert a brief description of work performed under Owner's separate contract>.**
- E. Future Work Not Part of this Contract: The Contract Documents include requirements that will allow Owner to carry out future work following completion of this Project; provide for the following future work:
1. **<Insert description of future work requiring consideration during construction of the Work of this Contract>.**

1.9 OWNER'S PRODUCT PURCHASE CONTRACTS

- A. Owner has negotiated Product Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Owner will assign these Product Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.
1. Contractor's responsibilities are same as if Contractor had negotiated Product Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.
- B. Owner's Product Purchase Contracts Information:
1. **<Insert product name>: See Section <Insert Section number> "<Insert Section title>."**
- a. Purchase Contract Firm and Representative: **<Insert name and contact information of Product Purchase contract firm and representative>.**
- b. Product Purchase Contract Scope: **[Furnishing material] [Material and installation labor] <Insert description of contract>.**
- c. Product Purchase Status: **[Price negotiated by Owner, to be incorporated into the Contract Sum by Contractor; see Section 012100 "Allowances" for cash allowance for Product Purchase contract] [Price negotiated and incorporated into the Contract Sum by Contractor] [Product reserved by Owner] [Order placed and deposit paid by Owner] [Order to be placed by Contractor] <Insert description of status of Product Purchase contract>.**
- d. Quantity: **<Insert quantity ordered>.**
- e. Other Requirements: **<Insert special requirements>.**

1.10 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFICI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
2. Provide for delivery of Owner-furnished products to Project site.

3. Upon delivery, inspect, with Contractor present, delivered items.
 - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
 4. Obtain manufacturer's inspections, service, and warranties.
 5. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
 3. Receive, unload, handle, store, protect, and install Owner-furnished products.
 4. Make building services connections for Owner-furnished products.
 5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
 6. Repair or replace Owner-furnished products damaged following receipt.
- C. Owner-Furnished/Contractor-Installed (OFI) Products:
1. <Insert description, in separate subparagraphs, for each Owner-furnished/Contractor-installed product>.
- 1.11 OWNER-FURNISHED/OWNER-INSTALLED (OFI) PRODUCTS
- A. The Owner will furnish and install products indicated.
- B. Owner-Furnished/Owner-Installed (OFI) Products:
1. <Insert description, in separate subparagraphs, for each Owner-furnished/Owner-installed product>.
- 1.12 CONTRACTOR-FURNISHED/OWNER-INSTALLED (CFI) PRODUCTS
- A. Contractor shall furnish products indicated. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.
- B. Contractor-Furnished/Owner-Installed (CFI) Products:
1. <Insert description, in separate subparagraphs, for each Contractor-furnished/Owner-installed product>.
- 1.13 CONTRACTOR'S USE OF SITE AND PREMISES
- A. Unrestricted Use of Site: **[Each]** 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. Restricted Use of Site: **[Each]** Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

- C. Limits on Use of Site: Limit use of Project site to [Work in areas] [areas within the Contract limits] indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Limits on Use of Site: Confine construction operations to <Insert description of areas where work is permitted>.
 2. Limits: Limit site disturbance, including earthwork and clearing of vegetation, to **40 feet** beyond building perimeter; **10 feet** beyond surface walkways, patios, surface parking, and utilities less than **12 inches** in diameter; **15 feet** beyond primary roadway curbs and main utility branch trenches; and **25 feet** beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.
 3. Limits: Limit site disturbance, including earthwork and clearing of vegetation, to **40 feet** beyond building perimeter; **15 feet** beyond surface walkways, patios, surface parking, and utilities; and **25 feet** beyond constructed areas with permeable surfaces that require additional staging areas to limit compaction in the constructed areas.
 4. Driveways, Walkways and Entrances: Keep driveways[**parking garage,**] [**loading areas,**] and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- D. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- E. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.14 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy Project site and [existing] [adjacent] building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 2. Notify Owner not less than [72] <Insert number> hours in advance of activities that will affect Owner's operations.
- B. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 2. Provide not less than [72] <Insert number> hours' notice to Owner of activities that will affect Owner's operations.
- C. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.15 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between <Insert time> a.m. to <Insert time> p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
 1. Weekend Hours: <Insert restrictions on times permitted for weekend work>.
 2. Early Morning Hours: <Insert restrictions or references to regulations by authorities having jurisdiction for restrictions on noisy work>.
 3. Work in Existing Building: <Insert restrictions on times permitted and other Owner's restrictions>.
 4. Hours for Utility Shutdowns: <Insert Owner's restrictions>.
 5. Hours for [Core Drilling] <Insert noisy activity>: <Insert Owner's restrictions>.
- C. On-Site Work Day Restrictions: Do not perform work [resulting in utility shutdowns] [or] [resulting in noisy activity] on-site during work black-out days indicated in Document 003113 "Preliminary Schedules."
- D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify [Architect] [Construction Manager] [Owner] not less than [two] <Insert number> days in advance of proposed utility interruptions.
 2. Obtain [Architect's] [Construction Manager's] [Owner's] written permission before proceeding with utility interruptions.
- E. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 1. Notify [Architect] [Construction Manager] [Owner] not less than [two] <Insert number> days in advance of proposed disruptive operations.
 2. Obtain [Architect's] [Construction Manager's] [Owner's] written permission before proceeding with disruptive operations.
- F. Nonsmoking Building: Smoking is not permitted within the building or within **25 feet** of entrances, operable windows, or outdoor-air intakes.
- G. Smoking and Controlled Substance Restrictions: Use of tobacco products [, **alcoholic beverages,**] and other controlled substances [within the existing building] [on Project site] [on Owner's property] is not permitted.
- H. Employee Identification: [Provide] [Owner will provide] identification tags for Contractor personnel working on Project site. Require

personnel to use identification tags at all times.

- I. Employee Screening: Comply with Owner's requirements for **[drug]** **[and]** **[background]** screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.

1.16 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. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations **[scheduled on Drawings]** **[and]** **[published as part of the U.S. National CAD Standard]**.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.17 MISCELLANEOUS PROVISIONS

- A. **<Insert miscellaneous provisions>.**

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Document 002600 "Procurement Substitution Procedures" for requirements for substitution requests prior to award of Contract.
 - 2. Section 012100 "Allowances" for products selected under an allowance.
 - 3. Section 012300 "Alternates" for products selected under an alternate.
 - 4. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form **[provided in Project Manual] [that is part of web-based Project management software] [acceptable to Architect]**.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

- e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from [ICC-ES] <Insert applicable code organization>.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within [seven] <Insert number> days of receipt of a request for substitution. Architect will notify Contractor [through Construction Manager] of acceptance or rejection of proposed substitution within [15] <Insert number> days of receipt of request, or [seven] <Insert number> days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

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

1.5 PROCEDURES

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

1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than [15] <Insert number> days prior to time required for preparation and review of related submittals.
- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Requested substitution provides sustainable design characteristics that specified product provided for compliance with

- LEED requirements.
- c. Requested substitution provides sustainable design characteristics that specified product provided for compliance with IgCC requirements.
- d. Requested substitution provides sustainable design characteristics that specified product provided for compliance with ASHRAE 189.1 requirements.
- e. Requested substitution provides sustainable design characteristics that specified product provided for compliance with Green Globes requirements.
- f. Substitution request is fully documented and properly submitted.
- g. Requested substitution will not adversely affect Contractor's construction schedule.
- h. Requested substitution has received necessary approvals of authorities having jurisdiction.
- i. Requested substitution is compatible with other portions of the Work.
- j. Requested substitution has been coordinated with other portions of the Work.
- k. Requested substitution provides specified warranty.
- l. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience:

1. Not allowed **[unless otherwise indicated]**.
2. Architect will consider requests for substitution if received within **[60]** **<Insert number>** days after **[commencement of the Work]** **[the Notice to Proceed]** **[the Notice of Award]**. Requests received after that time may be considered or rejected at discretion of Architect.
 - a. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - 1) Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - 2) Requested substitution does not require extensive revisions to the Contract Documents.
 - 3) Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - 4) Requested substitution provides sustainable design characteristics that specified product provided for compliance with LEED requirements.
 - 5) Requested substitution provides sustainable design characteristics that specified product provided for compliance with IgCC requirements.
 - 6) Requested substitution provides sustainable design characteristics that specified product provided for compliance with ASHRAE 189.1 requirements.
 - 7) Requested substitution provides sustainable design characteristics that specified product provided for compliance with Green Globes requirements.
 - 8) Substitution request is fully documented and properly submitted.
 - 9) Requested substitution will not adversely affect Contractor's construction schedule.
 - 10) Requested substitution has received necessary approvals of authorities having jurisdiction.
 - 11) Requested substitution is compatible with other portions of the Work.
 - 12) Requested substitution has been coordinated with other portions of the Work.
 - 13) Requested substitution provides specified warranty.
 - 14) If requested substitution involves more than one contractor, requested substitution has been coordinated

with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
 - 2. Section 013100 "Project Management and Coordination" for requirements for forms for contract modifications provided as part of web-based Project management software.

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 **[AIA Document G710]** **[form included in Project Manual]** **[web-based Project management software]**.

1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: **[Architect]** **[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 **[Architect]** **[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,]** **<Insert number of days>** 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.
 - e. Quotation Form: Use **[forms provided by Owner. Sample copies are included in Project Manual]** **[forms acceptable to Architect]** **[form provided as part of web-based Project management software]**.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to **[Architect]** **[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.
7. Proposal Request Form: Use **[form provided by Owner. Sample copy is included in Project Manual] [form acceptable to Architect] [form provided as part of web-based Project management software]**.

1.4 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, **[Architect] [Construction Manager]** will issue a Change Order for signatures of Owner and Contractor on **[AIA Document G701] [AIA Document G701CMA] [form included in Project Manual] [form provided as part of web-based Project management software]**.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: **[Architect] [Construction Manager]** may issue a Construction Change Directive on **[AIA Document G714] [AIA Document G714CMA] [form included in Project Manual] [form provided as part of web-based Project management software]**. 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.

1.7 WORK CHANGE DIRECTIVE

- A. Work Change Directive: **[Architect] [Construction Manager]** may issue a Work Change Directive on **[EJCDC Document C-940] [form**

included in Project Manual] [form provided as part of web-based Project management software]. 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 Requirements:
 - 1. Document 004373 "Proposed Schedule of Values Form" for requirements for furnishing proposed schedule of values with bid.
 - 2. Section 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 3. Section 012200 "Unit Prices" for administrative requirements governing the use of unit prices.
 - 4. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 5. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
 - 6. Section 018113.13 "Sustainable Design Requirements - LEED 2009 for New Construction and Major Renovations" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 7. Section 018113.16 "Sustainable Design Requirements - LEED 2009 for Commercial Interiors" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 8. Section 018113.19 "Sustainable Design Requirements - LEED 2009 for Core and Shell Development" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 9. Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 10. Section 018113.14 "Sustainable Design Requirements - LEED v4 BD+C" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 11. Section 018113.17 "Sustainable Design Requirements - LEED v4 ID+C" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 12. Section 018113.43 "Sustainable Design Requirements - ASHRAE 189.1" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.
 - 13. Section 018113.53 "Sustainable Design Requirements - Green Globes" for administrative requirements governing submittal of cost breakdown information required for sustainable design documentation.

1.2 DEFINITIONS

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

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule. [**Cost-Loaded Critical Path Method Schedule may serve to satisfy requirements for the schedule of values.**]

1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 2. Submit the schedule of values to Architect[**through Construction Manager**] at earliest possible date, but no later than **[seven]** **<Insert number>** days before the date scheduled for submittal of initial Applications for Payment.
 3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
 4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
 5. Subschedules for Separate Design Contracts: Where the Owner has retained design professionals under separate contracts who will each provide certification of payment requests, provide subschedules showing values coordinated with the scope of each design services contract, as described in Section 011000 "Summary."
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Owner's Project number.
 - d. Name of Architect.
 - e. Architect's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 2. Arrange schedule of values consistent with format of **[AIA Document G703]** **[EJCDC Document C-620]** **<Insert name and designation of standard form>**.
 3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of **[five]** **<Insert number>** percent of 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.

6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
7. Purchase Contracts: Provide a separate line item in the schedule of values for each Purchase contract. Show line-item value of Purchase contract. Indicate Owner payments or deposits, if any, and balance to be paid by Contractor.
8. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
9. Overhead Costs, Separate Line Items: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
10. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
11. Closeout Costs: Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling **[five]** **<Insert number>** percent of the Contract Sum and subcontract amount.
12. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect **[and Construction Manager]** and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Architect by the **<Insert day>** of the month. The period covered by each Application for Payment is one month, ending on the **[last day of the month]** **<Insert specific day of the month>**.
 1. Submit draft copy of Application for Payment **[seven]** **<Insert number>** days prior to due date for review by Architect.
- D. Application for Payment Forms: Use **[AIA Document G702 and AIA Document G703]** **[AIA Document G703 and AIA Document G732]** **[EJCDC Document C-620]** **<Insert name and designation of standard form>** as form for Applications for Payment.
 1. Other Application for Payment forms proposed by the Contractor may be acceptable to **[Architect]** **[Construction Manager]** and Owner. Submit forms for approval with initial submittal of schedule of values.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. **[Architect]** **[Construction Manager]** will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored,

but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- G. Transmittal: Submit **[three]** **<Insert number>** signed and notarized original copies of each Application for Payment to **[Architect]** **[Construction Manager]** by a method ensuring receipt **[within 24 hours]**. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from **[entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment]** **[subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application]**.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 5. Products list (preliminary if not final).
 6. Sustainable design action plans, including preliminary project materials cost data.
 7. Schedule of unit prices.
 8. Submittal schedule (preliminary if not final).
 9. List of Contractor's staff assignments.
 10. List of Contractor's principal consultants.
 11. Copies of building permits.
 12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 13. Initial progress report.
 14. Report of preconstruction conference.

15. Certificates of insurance and insurance policies.
 16. Performance and payment bonds.
 17. Data needed to acquire Owner's insurance.
- J. 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.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- K. 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. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. 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.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

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 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. Web-based Project management software package.
 - 6. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
 - 2. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 3. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 4. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
 - 5. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.2 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, [**Construction Manager**,]Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within [15] <Insert number> days of starting construction operations, submit a list of key personnel

assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, **[in web-based Project software directory,]** and in prominent location in **[each]** built facility. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

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

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings [**by multiple contractors**] in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling[, **raised access floor**,] and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:

- a. Runs of vertical and horizontal conduit **1-1/4 inches** in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Drawing Process: Prepare coordination drawings in the following manner:
1. Schedule submittal and review of Fire Sprinkler, Plumbing, HVAC, and Electrical Shop Drawings to make required changes prior to preparation of coordination drawings.
 2. Commence routing of coordination drawing files with HVAC Installer, who will provide drawing plan files denoting approved ductwork. HVAC Installer will locate ductwork and piping on a single layer, using orange color. Forward drawings to Plumbing Installer.
 3. Plumbing Installer will locate plumbing and equipment on a single layer, using blue color.
 4. Fire Sprinkler Installer will locate piping and equipment, using red color. Fire Sprinkler Installer shall forward drawing files to Electrical Installer.
 5. Electrical Installer will indicate service and feeder conduit runs and equipment in green color. Electrical Installer shall forward drawing files to Communications and Electronic Safety and Security Installer.
 6. Communications and Electronic Safety and Security Installer will indicate cable trays and cabling runs and equipment in purple color. Communications and Electronic Safety and Security Installer shall forward completed drawing files to Contractor.
 7. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.
- D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format:
 - a. Same digital data software program, version, and operating system as original Drawings.
 - b. **[DWG] [DXF] [DGN]**, Version **<Insert designation>**, operating in **[Microsoft Windows] [Apple Macintosh]** operating system.
 2. File Submittal Format: Submit or post coordination drawing files using **[format same as file preparation format] [PDF format]**.
 3. BIM File Incorporation: **[Develop and incorporate] [Construction Manager will incorporate Contractor's]** coordination drawing files into BIM established for Project.
 - a. **[Perform] [Construction Manager will perform]** three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in <Insert name and version of digital data software program and operating system>.
 - c. Contractor shall execute a data licensing agreement in the form of [AIA Document C106] [Agreement included in this Project Manual] [Agreement form acceptable to Owner and Architect].

1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Project name.
 2. Owner name.
 3. Owner's Project number.
 4. Name of Architect[and Construction Manager].
 5. Architect's Project number.
 6. Date.
 7. Name of Contractor.
 8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: [AIA Document G716] [Form bound in Project Manual] [Software-generated form with substantially the same content as indicated above, acceptable to Architect].
 1. Attachments shall be electronic files in PDF format.
- D. Architect's[and Construction Manager's] Action: Architect[and Construction Manager] will review each RFI, determine action required, and respond. Allow [three] [seven] <Insert number> days for Architect's response for each RFI. RFIs received by Architect[or Construction Manager] after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect **[or Construction Manager]** of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect **[and Construction Manager]** in writing within **[5]** **<Insert number>** days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log **[weekly]** **<Insert time>**. **[Use software log that is part of web-based Project management software.] [Include the following:] [Software log with not less than the following:]**
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect **[and Construction Manager]**.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's **[and Construction Manager'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.
- F. On receipt of Architect's **[and Construction Manager's]** action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect **[and Construction Manager]** within **[three]** **[seven]** **<Insert number>** days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Architect's Data Files Not Available: Architect will not provide Architect's **[BIM model]** **[CAD drawing]** digital data files for Contractor's use during construction.
- B. Use of Architect's Digital Data Files: Digital data files of Architect's **[BIM model]** **[CAD drawings]** will be provided by Architect for Contractor's use during construction.
 1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in **<Insert name and version of digital drawing software**

- program and operating system>.
4. Contractor shall execute a data licensing agreement in the form of [AIA Document C106 Digital Data Licensing Agreement] [Agreement included in Project Manual] [Agreement form acceptable to Owner and Architect].
 - a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of [AIA Document C106] [Agreement included in this Project Manual] [Agreement acceptable to Owner and Architect].
 5. <Insert additional conditions on which digital data drawing files will made available>.
 6. The following digital data files will be furnished for each appropriate discipline:
 - a. Floor plans.
 - b. Reflected ceiling plans.
 - c. <Insert name of digital data file>.
- C. Web-Based Project Management Software Package: [Provide, administer, and use] [Use Architect's] [Use Owner's] [Use Construction Manager's] web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 - m. <Insert description of software feature>.
 2. Provide up to [seven] <Insert number> Project management software user licenses for use of Owner[, Owner's Commissioning Authority] [, Construction Manager], Architect, and Architect's consultants. Provide [eight] <Insert number> hours of software training at Architect's office for web-based Project software users.
 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
 4. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Autodesk, Inc.
 - b. Corecon Technologies, Inc.
 - c. Deltek Inc.
 - d. Meridian Systems, Inc.
 - e. Newforma, Inc.
 - f. Procore Technologies, Inc.
 - g. Viewpoint, Inc.; a Trimble Company.
 - h. <Insert manufacturer's name>.
5. Basis-of-Design Product: Subject to compliance with requirements, provide <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
- D. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
 1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

- A. General: **[Schedule and conduct]** **[Construction Manager will 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 a minimum of **[seven]** <Insert number> days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner[, **Construction Manager,**] and Architect, within **[three]** <Insert number> days of the meeting.
- B. Preconstruction Conference: **[Architect will schedule and conduct]** **[Construction Manager will schedule and conduct]** **[Schedule and conduct]** a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than **[15]** <Insert number> days after execution of the Agreement.
 1. Attendees: Authorized representatives of Owner[, **Owner's Commissioning Authority,**] [, **Construction Manager,**] Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.

- f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Sustainable design requirements.
 - o. Preparation of Record Documents.
 - p. Use of the premises[**and existing building**].
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - x. Parking availability.
 - y. Office, work, and storage areas.
 - z. Equipment deliveries and priorities.
 - aa. First aid.
 - bb. Security.
 - cc. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Sustainable Design Requirements Coordination Conference: **[Owner will schedule and conduct]** **[Construction Manager will schedule and conduct]** a sustainable design coordination conference before starting construction, at a time convenient to Owner[, **Construction Manager,**] Architect, and Contractor.
- 1. Attendees: Authorized representatives of Owner, **[Owner's Commissioning Authority,]** **[Construction Manager,]** Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:
 - a. Sustainable design Project checklist.
 - b. General requirements for sustainable design-related procurement and documentation.
 - c. Project closeout requirements and sustainable design certification procedures.
 - d. Role of sustainable design coordinator.
 - e. Construction waste management.
 - f. Construction operations and sustainable design requirements and restrictions.
 - 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect[, **Construction Manager**] [, and **Owner's Commissioning Authority**] of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- E. Project Closeout Conference: **[Schedule and conduct]** **[Construction Manager will schedule and conduct]** a project closeout conference, at a time convenient to Owner and Architect, but no later than **[90]** **<Insert number>** days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, **[Owner's Commissioning Authority,]** **[Construction Manager,]** Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

- a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for completing sustainable design documentation.
 - f. Requirements for preparing operations and maintenance data.
 - g. Requirements for delivery of material samples, attic stock, and spare parts.
 - h. Requirements for demonstration and training.
 - i. Preparation of Contractor's punch list.
 - j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - k. Submittal procedures.
 - l. Coordination of separate contracts.
 - m. Owner's partial occupancy requirements.
 - n. Installation of Owner's furniture, fixtures, and equipment.
 - o. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- F. Progress Meetings: **[Conduct]** **[Construction Manager will conduct]** progress meetings at **[weekly]** **[biweekly]** **[monthly]** **[regular]** **<Insert appropriate interval>** intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner[, **Owner's Commissioning Authority**] [, **Construction Manager**,] and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Status of sustainable design documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site use.
 - 10) Temporary facilities and controls.

- 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of Proposal Requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- G. Coordination Meetings: **[Conduct]** **[Construction Manager will conduct]** **[Project Coordinator will conduct]** Project coordination meetings at **[weekly]** **[biweekly]** **[monthly]** **[regular]** **<Insert appropriate interval>** intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner[, **Owner's Commissioning Authority**] [, **Construction Manager**,] 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 meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined 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. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.

- 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Unusual event reports.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for preparing a combined Contractor's Construction Schedule.
 - 2. Section 012900 "Payment Procedures" for schedule of values and requirements for use of cost-loaded schedule for Applications for Payment.
 - 3. Section 014000 "Quality Requirements" for schedule of tests and inspections.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.

1. Float time **[belongs to Owner]** **[is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date]**.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of labor and equipment necessary for completing an activity as scheduled.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file.
2. PDF file.
3. **[Two]** **<Insert number>** paper copies, of sufficient size to display entire period or schedule, as required.

B. Startup construction schedule.

1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports to contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from **[commencement of the Work]** **[the Notice to Proceed]** until most recent Application for Payment.

F. Construction Schedule Updating Reports: Submit with Applications for Payment.

G. Daily Construction Reports: Submit at **[weekly]** **[monthly]** intervals.

H. Material Location Reports: Submit at **[weekly]** **[monthly]** intervals.

I. Site Condition Reports: Submit at time of discovery of differing conditions.

J. Unusual Event Reports: Submit at time of unusual event.

K. Qualification Data: For scheduling consultant.

1.4 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including [phasing] [work stages] [area separations] [interim milestones] [and] [partial Owner occupancy].
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures[, including commissioning activities].
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.5 COORDINATION

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

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
 - 1. Use [Microsoft Project] [Primavera] [Meridian Prolog] [scheduling component of Project management software package specified in Section 013100 "Project Management and Coordination,"] <Insert name of specific software> for current [Windows] [Macintosh] operating system.
- B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting, using CPM scheduling.
 - 1. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 - 2. Meetings: Scheduling consultant to attend all meetings related to Project progress, alleged delays, and time impact.
- C. Time Frame: Extend schedule from date established for [commencement of the Work] [the Notice of Award] [the Notice to Proceed] to date of [Substantial Completion] [Final Completion].

1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than [20] <Insert number> days, unless specifically allowed by Architect.
 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with Separate Contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. <Insert list of major items or pieces of equipment>.
 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 5. Startup and Testing Time: Include no fewer than [15] <Insert number> days for startup and testing.
 6. Commissioning Time: Include no fewer than [15] <Insert number> days for commissioning.
 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's[**and Construction Manager's**] administrative procedures necessary for certification of Substantial Completion.
 8. Punch List and Final Completion: Include not more than [30] <Insert number> days for completion of punch list items and Final Completion.
- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.

- e. Use-of-premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
- 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
- 8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- 9. Other Constraints: <Insert constraints not indicated elsewhere>.
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion[.], and the following interim milestones:
 - 1. Temporary enclosure and space conditioning.
 - 2. <Insert milestones not indicated elsewhere>.
- G. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
 - 1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- H. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- I. Contractor's Construction Schedule Updating: At **[monthly]** **<Insert time>** intervals, update schedule to reflect actual construction progress and activities. Issue schedule **[one week]** **<Insert time>** before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Final Completion percentage for each activity.
- J. Recovery Schedule: When periodic update indicates the Work is **[14]** **<Insert number>** or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- K. Distribution: Distribute copies of approved schedule to Architect[, **Construction Manager**,] Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.
- 1.7 STARTUP CONSTRUCTION SCHEDULE
- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within **[seven]** **<Insert number>** days of date established for **[commencement of the Work]** **[the Notice to Proceed]** **[the Notice of Award]**.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first **[90]** **<Insert number>** days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- 1.8 GANTT-CHART SCHEDULE REQUIREMENTS
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within **[30]** **<Insert number>** days of date established for **[commencement of the Work]** **[the Notice to Proceed]** **[the Notice of Award]**.
1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in [10] <Insert number> percent increments within time bar.

1.9 CPM SCHEDULE REQUIREMENTS

- A. Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within [14] <Insert number> days of date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award]. Outline significant construction activities for the first [90] <Insert number> days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a[cost- and resource-loaded,] time-scaled CPM network analysis diagram for the Work.
 1. Develop network diagram in sufficient time to submit CPM schedule, so it can be accepted for use no later than [60] <Insert number> days after date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award].
 - a. Failure to include any work item required for performance of this Contract must not excuse Contractor from completing all work within applicable completion dates.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and inspection.
 - j. Commissioning.
 - k. Punch list and Final Completion.
 - l. Activities occurring following Final Completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates to be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, **[sustainable design documentation]**, and demonstration and training (if applicable), in the amount of [5] **<Insert number>** percent of the Contract Sum.
 - a. Each activity cost to reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities to equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.

- a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
- b. Submit value summary printouts **[one week]** <Insert time> before each regularly scheduled progress meeting.

1.10 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Testing and inspection.
 8. Accidents.
 9. Meetings and significant decisions.
 10. Unusual events.
 11. Stoppages, delays, shortages, and losses.
 12. Meter readings and similar recordings.
 13. Emergency procedures.
 14. Orders and requests of authorities having jurisdiction.
 15. Change Orders received and implemented.
 16. **[Construction]** **[Work]** Change Directives received and implemented.
 17. Services connected and disconnected.
 18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Material Location Reports: At **[weekly]** **[monthly]** intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List to be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
 1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
 1. Submit unusual event reports directly to Owner within **[one]** <Insert number> day(s) of an occurrence. Distribute copies of

report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Time-lapse sequence construction photographs.
 - 5. Final Completion construction photographs.
 - 6. Preconstruction video recordings.
 - 7. Periodic construction video recordings.
 - 8. Time-lapse sequence construction video recordings.
 - 9. Construction webcam.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 024116 "Structure Demolition" for photographic documentation before building demolition operations commence.
 - 4. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
 - 5. Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.2 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each **[photograph]** **[and]** **[video recording]**. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within **[three]** **<Insert number>** days of taking photographs.
 - 1. Submit photos **[on CD-ROM or thumb-drive]** **[by uploading to web-based Project management software site]**. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description **[in file metadata tag]** **[in web-based Project management software site]**:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect **[and Construction Manager]**.
 - d. Name of Contractor.
 - e. Date photograph was taken.

- f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- C. Printed Photographs: Submit **[two]** <Insert number> sets of prints of each photographic view within **[seven]** <Insert number> days of taking photographs.
 - 1. Format: **8-by-10-inch** smooth-surface matte prints on single-weight, paper; enclosed back to back in clear plastic sleeves punched for three-ring binder. Include copy of key plan indicating each photograph's location and direction. Provide one binder for each set of prints.
 - 2. Identification: On back of each print, label with the following information:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect **[and Construction Manager]**.
 - d. Name of Contractor.
 - e. Date photograph was taken if not date stamped by camera.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- D. Video Recordings: Submit video recordings within **[seven]** <Insert number> days of recording.
 - 1. Submit video recordings **[on CD-ROM or thumb drive]** **[by uploading to web-based Project management software site]**. Include copy of key plan indicating each video's location and direction.
 - 2. Identification: With each submittal, provide the following information **[in file metadata tag]** **[on web-based Project management software site]**:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect **[and Construction Manager]**.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - 3. Transcript: Prepared on **8-1/2-by-11-inch** paper, punched and bound in three-ring binders. Provide label on front and spine. Include a cover sheet with label information. Include name of Project and date of video recording on each page.
- E. Time-Lapse Video: Submit time-lapse sequence video recordings within <Insert number> days of recording.
 - 1. Submit time-lapse sequence video recordings **[monthly]** <Insert frequency> **[on CD-ROM or thumb drive]** **[by uploading to web-based Project management software site]**.
 - 2. Identification: For each recording, provide the following information **[in file metadata tag]** **[on web-based Project management software site]**:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect **[and Construction Manager]**.
 - d. Name of Contractor.
 - e. Date(s) and time(s) video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1.3 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.
- B. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with a record of providing satisfactory services similar to those required for Project.

1.4 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of [12] <Insert number> megapixels, and at an image resolution of not less than [3200 by 2400] <Insert resolution> pixels[, and with vibration-reduction technology]. Use flash in low light levels or backlit conditions.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of [12] <Insert number> megapixels and capable of recording in full high-definition mode[with vibration-reduction technology]. Provide supplemental lighting in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Metadata: Record accurate date and time [and GPS location data]from camera.
- E. File Names: Name media files with [date] [Project area] <Insert requirement> and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by [Architect] [Construction Manager].
 - 1. Flag [excavation areas] [construction limits] before taking construction photographs.
 - 2. Take [20] <Insert number> photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take [20] <Insert number> photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.

2. Underslab services.
 3. Piping.
 4. Electrical conduit.
 5. Waterproofing and weather-resistant barriers.
 6. **<Insert description of Work>**.
- E. Periodic Construction Photographs: Take [20] [50] **<Insert number>** photographs [weekly] [monthly] **<Insert time interval>** [coinciding with the cutoff date associated with each Application for Payment]. Select vantage points to show status of construction and progress since last photographs were taken.
- F. Time-Lapse Sequence Construction Photographs: Take [20] **<Insert number>** photographs as indicated, to show status of construction and progress since last photographs were taken.
1. Frequency: Take photographs [monthly, on the same date each month] [weekly, on the same day each week] **<Insert time interval>**.
 2. Vantage Points: Following suggestions by [Architect] [Construction Manager] and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than [two] **<Insert number>** of the required shots from same vantage point each time, to create a time-lapse sequence as follows:
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Above-grade structural framing.
 - c. Exterior building enclosure.
 - d. Interior Work, through date of Substantial Completion.
 - e. **<Insert vantage point>**.
- G. Final Completion Construction Photographs: Take [20] [50] [100] **<Insert number>** photographs after date of Substantial Completion for submission as Project Record Documents. [Architect] [Construction Manager] will inform photographer of desired vantage points.
- H. Additional Photographs: Architect [or Construction Manager] may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum [or in the allowance for construction photographs].
1. Three days' notice will be given, where feasible.
 2. In emergency situations, take additional photographs within 24 hours of request.
 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs are to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

1.6 CONSTRUCTION VIDEO RECORDINGS

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.

- B. Narration: Describe scenes on video recording by **[audio narration by microphone while]** **[or]** **[dubbing audio narration off-site after]** video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
 - 1. Confirm date and time at beginning and end of recording.
 - 2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- C. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.
- D. Preconstruction Video Recording: Before starting **[excavation]** **[demolition]** **[construction]**, record video recording of Project site and surrounding properties from different vantage points, as directed by **[Architect]** **[Construction Manager]**.
 - 1. Flag **[excavation areas]** **[construction limits]** before recording construction video recordings.
 - 2. Show existing conditions adjacent to Project site before starting the Work.
 - 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of **[excavation]** **[demolition]** **[construction]**.
 - 4. Show protection efforts by Contractor.
- E. Periodic Construction Video Recordings: Record video recording **[monthly]** **[weekly]** **<Insert time interval>** **<coinciding with the cutoff date associated with each Application for Payment>**. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time to be **[30]** **<Insert number>** minutes(s).
- F. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.
 - 1. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every **[five]** **<Insert time>** minutes, from same vantage point each time, to create a time-lapse sequence of **[30 minutes]** **<Insert time>** in length as follows:
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Above-grade structural framing.
 - c. Exterior building enclosure.
 - d. **<Insert construction phase>**.
 - 2. Timer: Provide timer to automatically start and stop video recorder, so recording occurs only during **[daylight]** **[construction work]** hours.
 - 3. Vantage Points: Following suggestions by **[Architect]** **[Construction Manager]** and Contractor, photographer to select vantage points.

1.7 CONSTRUCTION WEBCAM

- A. Webcam: Provide **[one]** **[two]** **<Insert number>** fixed-location camera(s) with weatherproof housing, mounted to provide unobstructed view of construction site from location approved by Architect, with the following characteristics:
 - 1. **[Static view]** **[Remotely controllable view with mouse-click user navigation for horizontal pan, vertical tilt, and optical zoom of 500 percent minimum]**.
 - 2. Capable of producing minimum **[8]** **[12]** **<Insert number>** megapixel images.
 - 3. Provide **[pole mount,]** **[parapet mount,]** power supply, **[solar power station,]** active high-speed data connection to service provider's network, and static public IP address for each camera.

- B. Live Streaming Images: Provide web-accessible image of current site image, updated at [five] [15] <Insert number>-minute intervals [during daytime operation] [when construction is underway].
- C. Web-Based Interface: Provide online interface to allow viewing of each high-definition digital still image captured and stored during construction, from the Internet.
 - 1. Access Control: Provide password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
 - 2. Software: Provide responsive software interface for use on computer, tablet, and mobile screens with accompanying iPhone/iPad app and Android apps.
 - 3. Storage: Maintain images on the website for reference during entire construction period, and for not less than 30 days after Final Completion. Provide sufficient memory on remote server to store all Project images.
 - 4. Online Interface: Provide website interface with Project and client information and logos, calendar-based navigation interface for selecting images, and pan and zoom capability within high-definition images.
 - 5. Forward and Reverse: Provide capability to browse through images, moving forward and backward in time by individual image and by day.
 - 6. Slideshow: Provide capability to automatically display current images from sites when there are three or more cameras used.
 - 7. Time-Lapse: Provide capability for online display of project time-lapse.
 - 8. Dashboard: Provide capability to view thumbnails of all cameras on one screen.
 - 9. Weather: Provide corresponding weather data for each image captured.
 - 10. Provide public viewer open access[to most recent Project camera image].
- D. Maintain cameras and web-based access in good working order, in accordance with web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
5. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
6. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
7. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
8. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
9. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
10. Section 018113.13 "Sustainable Design Requirements - LEED 2009 for New Construction and Major Renovations" for sustainable design submittals.
11. Section 018113.16 "Sustainable Design Requirements - LEED 2009 for Commercial Interiors" for sustainable design submittals.
12. Section 018113.19 "Sustainable Design Requirements - LEED 2009 for Core and Shell Development" for sustainable design submittals.
13. Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools" for sustainable design submittals.
14. Section 018113.14 "Sustainable Design Requirements - LEED v4 BD+C" for sustainable design submittals.
15. Section 018113.17 "Sustainable Design Requirements - LEED v4 ID+C" for sustainable design submittals.
16. Section 018113.33 "Sustainable Design Requirements - IgCC" for sustainable design submittals.
17. Section 018113.43 "Sustainable Design Requirements - ASHRAE 189.1" for sustainable design submittals.
18. Section 018113.53 "Sustainable Design Requirements - Green Globes" for sustainable design 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. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's[**and Construction Manager's**] final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

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**] **<Insert dimensions>** 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**] **<Insert number>** paper copies of each submittal unless otherwise indicated. Architect[, **through Construction Manager**,] will return [**two**] **<Insert number>** copies.
 4. Informational Submittals: Submit [**two**] **<Insert number>** paper copies of each submittal unless otherwise indicated. Architect[**and Construction Manager**] will not return copies.
 5. Additional Copies: Unless additional copies are required for final submittal, and unless Architect[**or Construction Manager**] observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 6. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using [**AIA Document G810**] [**facsimile of sample form included in Project Manual**] transmittal form.
- E. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- F. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.
- 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.
 - a. Architect[, **through Construction Manager**,] will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management 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.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. **[Architect reserves] [Architect and Construction Manager reserve]** the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on **[Architect's] [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] <Insert number>** days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. **[Architect] [Construction Manager]** will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow **[15] <Insert number>** days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow **[21] <Insert number>** days for initial review of each submittal.
 - a. **<Insert list of Specification Sections requiring sequential review>**.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow **[15] <Insert number>** days for review of each submittal. Submittal will be returned to **[Architect] [Construction Manager, through Architect,]** before being returned to Contractor.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect **[and Construction Manager]**.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's **[and Construction Manager's]** action stamp.
- 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 concurrently 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]** **<Insert dimensions>**.
 - a. **[Two]** opaque (bond) copies of each submittal. Architect **[, through Construction Manager,]** will return **[one]** **<Insert number>** copy(ies).
 - b. **[Three]** **<Insert number>** opaque copies of each submittal. Architect **[and Construction Manager]** will retain **[two]** **<Insert number>** copies; remainder will be returned.
 3. BIM Incorporation: **[Develop and incorporate]** **[Construction Manager will incorporate Contractor's]** Shop Drawing files into

BIM established for Project.

- C. Samples: Submit Samples for review of type, 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 Management 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]** <Insert number> 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]** <Insert number> sets of Samples. Architect[**and Construction Manager**] will retain **[two]** <Insert number> 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:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- 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 AWS B2.1/B2.1M 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 substrate preparation and primers required.
 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.
- C. BIM Incorporation: **[Incorporate]** **[Construction Manager will incorporate]** delegated design drawing and data files into BIM established for Project.
 1. Prepare delegated design drawings in the following format: **[Same digital data software program, version, and operating system as original Drawings]** **<Insert software name and version>**.

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]** **[indication in web-based Project management software]**. 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**].
1. PDF Submittals: Architect[**and Construction Manager**] will indicate, via markup on each submittal, the appropriate action[.], **as follows:**
- a. <Insert description of each action indicated on Architect's (and Construction Manager's) stamp>.
2. Paper Submittals: Architect[**and Construction Manager**] will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action[.], **as follows:**
- a. <Insert description of each action indicated on Architect's (and Construction Manager's) stamp>.
3. Submittals by Web-Based Project Management Software: Architect[**and Construction Manager**] will indicate, on Project management software website, the appropriate action.
- a. Actions taken by indication on Project management software website have the following meanings:
- 1) <Insert description of each action indicated on Architect's (and Construction Manager's) stamp>.
- 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 [return without review] [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. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. 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.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, [**Commissioning Authority,**] [**Construction Manager,**] or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Requirements:
 - 1. Section 012100 "Allowances" for testing and inspection allowances.

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 and Inspections: 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 Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.

- d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
- 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
- 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- 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. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with 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 and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "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. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: 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.

1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is 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. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. 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. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. 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.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. 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 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within [10] <Insert number> days of [Notice of Award] [Notice to Proceed], and not less than [five] <Insert number> days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager [may also serve as Project superintendent] [does not have other Project responsibilities].
 - 2. <Insert qualifications appropriate to Project>.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 - 3. Owner-performed tests and inspections indicated in the Contract Documents[, including tests and inspections indicated to be performed by Commissioning Authority].
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 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. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. 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. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.9 QUALITY ASSURANCE

- A. 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 is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized

experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, 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, demonstrate, repair, and perform service on installations 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's Responsibilities:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
 - e. 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 Commissioning Authority**] [, **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**] **<Insert number>** days in advance of dates and times when mockups will be constructed.
 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who 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**] **<Insert number>** days for initial review and each re-review of each mockup.

7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

- L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for **[integrated exterior mockups]** **[preconstruction laboratory mockups]** **[and]** **[room mockups]**.

1.10 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. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor **[, and the Contract Sum will be adjusted by Change Order]**.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least **[24]** **<Insert number>** hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. 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 **[, Commissioning Authority]** **[, Construction Manager,]** and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect **[, Commissioning Authority,]** **[, 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. **Contractor's Associated Requirements and 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. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and 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.
- I. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents **[as a component of Contractor's quality-control plan]**. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
- 1. **Schedule Contents:** Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 - 2. **Distribution:** Distribute schedule to Owner, Architect, **[Commissioning Authority,]** **[Construction Manager,]** testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.
- 1.11 **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[, **Commissioning Authority**,] [, **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[**and Commissioning Authority**] [, **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.
7. <Insert requirements>.

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[, **Commissioning Authority's**,] [, **and Construction Manager's**] [and] [authorities' having jurisdiction] 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 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

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

1.2 INDUSTRY STANDARDS

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

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. **[Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."]** The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.
24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.
25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
33. ASME - ASME International; **(American Society of Mechanical Engineers (The))**; www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.

37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; www.bwfbadminton.com.
50. CARB - California Air Resources Board; www.arb.ca.gov.
51. CDA - Copper Development Association Inc.; www.copper.org.
52. CE - Conformite Europeenne (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
53. CEA - Canadian Electricity Association; www.electricity.ca.
54. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
55. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
56. CGA - Compressed Gas Association; www.cganet.com.
57. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
58. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
59. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
60. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
61. CPA - Composite Panel Association; www.compositepanel.org.
62. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
63. CRRC - Cool Roof Rating Council; www.coolroofs.org.
64. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
65. CSA - CSA Group; www.csagroup.org.
66. CSI - Cast Stone Institute; www.caststone.org.
67. CSI - Construction Specifications Institute (The); www.csiresources.org.
68. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
69. CTA - Consumer Technology Association; www.cta.tech.
70. CTI - Cooling Technology Institute; www.coolingtechnology.org.
71. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
72. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
73. DHI - Door and Hardware Institute; www.dhi.org.
74. ECIA - Electronic Components Industry Association; www.ecianow.org.
75. EIMA - EIFS Industry Members Association; www.eima.com.
76. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
77. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
78. ESTA - Entertainment Services and Technology Association; www.esta.org.
79. EVO - Efficiency Valuation Organization; www.evo-world.org.
80. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.
81. FGIA - Fenestration and Glazing Industry Alliance; <https://fgiaonline.org>.
82. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
83. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
84. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
85. FM Global - FM Global; www.fmglobal.com.

86. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridarooft.com.
87. FSA - Fluid Sealing Association; www.fluidsealing.com.
88. FSC - Forest Stewardship Council U.S.; www.fscus.org.
89. GA - Gypsum Association; www.gypsum.org.
90. GS - Green Seal; www.greenseal.org.
91. HI - Hydraulic Institute; www.pumps.org.
92. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
93. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
94. IAS - International Accreditation Service; www.iasonline.org.
95. ICC - International Code Council; www.iccsafe.org.
96. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
97. ICPA - International Cast Polymer Association (The); www.theicpa.com.
98. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
99. IEC - International Electrotechnical Commission; www.iec.ch.
100. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
101. IES - Illuminating Engineering Society; www.ies.org.
102. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
103. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
104. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
105. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
106. Intertek - Intertek Group; www.intertek.com.
107. ISA - International Society of Automation (The); www.isa.org.
108. ISFA - International Surface Fabricators Association; www.isfanow.org.
109. ISO - International Organization for Standardization; www.iso.org.
110. ITU - International Telecommunication Union; www.itu.int.
111. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
112. LPI - Lightning Protection Institute; www.lightning.org.
113. MBMA - Metal Building Manufacturers Association; www.mbma.com.
114. MCA - Metal Construction Association; www.metalconstruction.org.
115. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
116. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
117. MHI - Material Handling Industry; www.mhi.org.
118. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
119. MPI - Master Painters Institute; www.paintinfo.com.
120. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
121. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
122. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
123. NADCA - National Air Duct Cleaners Association; www.nadca.com.
124. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
125. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
126. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
127. NBI - New Buildings Institute; www.newbuildings.org.
128. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
129. NCMA - National Concrete Masonry Association; www.ncma.org.
130. NEBB - National Environmental Balancing Bureau; www.nebb.org.
131. NECA - National Electrical Contractors Association; www.necanet.org.
132. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
133. NEMA - National Electrical Manufacturers Association; www.nema.org.
134. NETA - InterNational Electrical Testing Association; www.netaworld.org.

135. NFHS - National Federation of State High School Associations; www.nfhs.org.
136. NFPA - National Fire Protection Association; www.nfpa.org.
137. NFPA - NFPA International; (see NFPA).
138. NFRC - National Fenestration Rating Council; www.nfrc.org.
139. NGA - National Glass Association; www.glass.org.
140. NHLA - National Hardwood Lumber Association; www.nhla.com.
141. NLGA - National Lumber Grades Authority; www.nlga.org.
142. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
143. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
144. NRCA - National Roofing Contractors Association; www.nrca.net.
145. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
146. NSF - NSF International; www.nsf.org.
147. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
148. NSPE - National Society of Professional Engineers; www.nspe.org.
149. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
150. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
151. NWFA - National Wood Flooring Association; www.nwfa.org.
152. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
153. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
154. PDI - Plumbing & Drainage Institute; www.pdionline.org.
155. PLASA - PLASA; www.plasa.org.
156. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
157. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
158. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
159. RFCI - Resilient Floor Covering Institute; www.rfci.com.
160. RIS - Redwood Inspection Service; (see WWPA).
161. SAE - SAE International; www.sae.org.
162. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
163. SDI - Steel Deck Institute; www.sdi.org.
164. SDI - Steel Door Institute; www.steeldoor.org.
165. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
166. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
167. SIA - Security Industry Association; www.securityindustry.org.
168. SJI - Steel Joist Institute; www.steeljoist.org.
169. SMA - Screen Manufacturers Association; www.smainfo.org.
170. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
171. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
172. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
173. SPIB - Southern Pine Inspection Bureau; www.spib.org.
174. SPRI - Single Ply Roofing Industry; www.spri.org.
175. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
176. SSINA - Specialty Steel Industry of North America; www.ssina.com.
177. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
178. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
179. SWI - Steel Window Institute; www.steelwindows.com.
180. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
181. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
182. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
183. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.

184. TIA - Telecommunications Industry Association (The); www.tiaonline.org.
185. TMS - The Masonry Society; www.masonrysociety.org.
186. TPI - Truss Plate Institute; www.tpinst.org.
187. TPI - Turfgrass Producers International; www.turfgrassod.org.
188. TRI - Tile Roofing Industry Alliance; www.tilerroofing.org.
189. UL - Underwriters Laboratories Inc.; www.ul.org.
190. UL LLC - UL LLC; www.ul.com.
191. USAV - USA Volleyball; www.usavolleyball.org.
192. USGBC - U.S. Green Building Council; www.usgbc.org.
193. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
194. WA - Wallcoverings Association; www.wallcoverings.org.
195. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
196. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
197. WDMA - Window & Door Manufacturers Association; www.wdma.com.
198. WI - Woodwork Institute; www.woodworkinstitute.com.
199. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
200. WWPA - Western Wood Products Association; www.wwpa.org.

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut für Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - U.S. Department of Commerce; www.commerce.gov.
3. DOD - U.S. Department of Defense; www.defense.gov.
4. DOE - U.S. Department of Energy; www.energy.gov.
5. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov.
6. DOS - U.S. Department of State; www.state.gov.
7. EPA - United States Environmental Protection Agency; www.epa.gov.
8. FAA - Federal Aviation Administration; www.faa.gov.
9. GPO - U.S. Government Publishing Office; www.gpo.gov.
10. GSA - U.S. General Services Administration; www.gsa.gov.
11. HUD - U.S. Department of Housing and Urban Development; www.hud.gov.
12. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov/.
13. NIST - National Institute of Standards and Technology; www.nist.gov.
14. OSHA - Occupational Safety & Health Administration; www.osha.gov.
15. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
16. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
17. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.

18. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
19. USP - U.S. Pharmacopeial Convention; www.usp.org.
20. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.
2. DOD - U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from U.S. General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
6. MILSPEC - Military Specification and Standards; (see DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. BEARHFTI; California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; (see BHGS).
2. BHGS; State of California Bureau of Household Goods and Services; (Formerly: California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation); www.bhgs.dca.ca.gov.
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDPPH/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; <https://tfsweb.tamu.edu/>.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 014339 - MOCKUPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Integrated exterior mockups.
2. Preconstruction laboratory mockups.
3. Room mockups.

B. Related Requirements:

1. Section 014000 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.
2. Section 019119.43 "Exterior Enclosure Commissioning" for testing building enclosure systems and assemblies as part of the exterior enclosure commissioning process.

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 DEFINITIONS

- A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as [freestanding temporary built elements] [part of permanent construction], consisting of multiple products, assemblies, and subassemblies.
- B. Preconstruction Laboratory Mockups: Integrated exterior mockups constructed at testing facility to verify performance characteristics.
- C. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting as indicated.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1. Meet with Owner, [Construction Manager,] Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in [integrated exterior] [preconstruction laboratory] [and] [room] mockups.
2. Review coordination of equipment and furnishings provided by the Owner for room mockups.
3. Review locations and extent of mockups.
4. Review testing procedures to be performed on mockups.
5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups [and testing] and maintain schedule for the Work.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For [integrated exterior] [preconstruction laboratory] [and] [room] mockups.
 - 1. Include plans, elevations, sections, and [mounting] [attachment] [and] [support] details.
 - 2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
 - 3. Include site location drawing[indicating orientation of mockup].
 - 4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.
- B. Delegated Design Submittal: For temporary structural supports for mockups not attached to building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Room Mockup Coordination Drawings: <Insert description of drawing type> [and other details], drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. <Insert requirements>.
- B. Qualification Data: For testing agency.
- C. Preconstruction Test Reports: For [integrated exterior] [preconstruction laboratory] mockups.

1.7 QUALITY ASSURANCE

- A. Preconstruction Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025].
- B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated[and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025] and acceptable to Owner and Architect.
- C. Build mockups to do the following:
 - 1. Verify selections made under Sample submittals.
 - 2. Demonstrate aesthetic effects.
 - 3. Demonstrate the qualities of products and workmanship.
 - 4. Demonstrate acceptable coordination between components and systems.
 - 5. Perform preconstruction testing, such as window air- and water-leakage testing.
- D. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the 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. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

E. Notifications:

1. Notify Architect[**and Construction Manager**] [**seven**] **<Insert number>** days in advance of the dates and times when mockups will be constructed.
2. Notify Architect[**and Construction Manager**] [**14**] **<Insert number>** days in advance of the dates and times when mockups will be tested.
3. Allow [**seven**] **<Insert number>** days for initial review and each re-review of each mockup.

F. Approval: Obtain Architect's[**and Construction Manager's**] approval of mockups before starting fabrication or construction of corresponding Work.

1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 COORDINATION

- A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.1 ~~PERFORMANCE REQUIREMENTS~~

- A. ~~Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design support structure for free-standing mockups.~~
- B. ~~Structural Performance:~~
1. ~~Seismic Performance: Mockups and support structure to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7] **<Insert requirement>**.~~
 2. ~~Wind Loads: As indicated on Drawings.~~
- C. ~~Mockup Testing Performance Requirements: Perform tests using design pressures and performance criteria indicated for assemblies and products that are specified in other Sections and incorporated into [integrated exterior] [preconstruction laboratory] mockups.~~

2.2 ~~INTEGRATED EXTERIOR MOCKUPS~~

- A. ~~Construct integrated exterior mockups [according to approved mockup Shop Drawings] [as indicated on Drawings]. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.~~

- B. — Design and construct foundation and superstructure to support free-standing integrated exterior mockups.
- C. — Build integrated exterior mockups using installers and construction methods that will be used in completed construction.
- D. — Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.
- E. — The Work of integrated exterior mockups includes, but is not limited to, the following:
 - 1. — Precast architectural concrete.
 - 2. — Masonry veneer.
 - 3. — Stone cladding.
 - 4. — Cold-formed metal framing and sheathing.
 - 5. — Air and weather barriers.
 - 6. — Thermal insulation.
 - 7. — Through-wall flashing.
 - 8. — Flashing and sheet metal trim.
 - 9. — Joint sealants.
 - 10. — Metal wall panels.
 - 11. — Aluminum-framed entrances and storefront.
 - 12. — Glazed curtain walls.
 - 13. — Aluminum windows.
 - 14. — Glazing.
 - 15. — ~~<Insert description>.~~
- F. — Photographic Documentation: Document construction of integrated exterior mockups with photographs in accordance with Section 013233 "Photographic Documentation." Provide photographs showing details of interface of different materials and assemblies.
 - 1. — Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.
- G. — Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain ~~[Architect's]~~ **[Construction Manager's]** approval for modifications.
- H. — Retain approved mockups constructed in place. Incorporate fully into the Work.

2.3 — PRECONSTRUCTION LABORATORY MOCKUPS

- A. — Construct preconstruction laboratory mockups ~~[according to approved Shop Drawings]~~ **[as indicated on Drawings]**. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements; and conduct performance testing indicated.
- B. — Build preconstruction laboratory mockups at testing agency facility using installers and construction methods that will be used at Project site.
- C. — Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in preconstruction laboratory mockups.

D. — The Work of preconstruction laboratory mockups includes, but is not limited to, the following:

1. — Precast architectural concrete.
2. — Masonry veneer.
3. — Stone cladding.
4. — Cold-formed metal framing and sheathing.
5. — Air and weather barriers.
6. — Thermal insulation.
7. — Through-wall flashing.
8. — Flashing and sheet metal trim.
9. — Joint sealants.
10. — Metal wall panels.
11. — Aluminum-framed entrances and storefront.
12. — Glazed curtain walls.
13. — Aluminum windows.
14. — Glazing.
15. — <Insert description>.

E. — Photographic Documentation: Document construction of preconstruction laboratory mockups with photographs in accordance with Section 013233 "Photographic Documentation." Provide photographs showing details of interface of different materials and assemblies:

1. — Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

F. — Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain [Architect's] [Construction Manager's] approval for modifications.

G. — When testing is complete, remove test specimens and test assemblies, and preconstruction laboratory mockups; do not reuse products on Project.

2.4 ROOM MOCKUPS

A. — Build room mockups [according to approved mockup Shop Drawings] [as indicated on Drawings] to evaluate constructability, demonstrate the coordination of trades and sequencing of Work, and to demonstrate aesthetic requirements. Include each visible finish, component, and equipment item within room mockups; include operable lighting.

B. — Provide room mockups of the following rooms:

1. — Classroom.
2. — Patient care room.
3. — Hotel guest room.
4. — Residential apartment unit.
5. — <Insert room name or description>.

C. — The Work of room mockups includes, but is not limited to, the following:

1. ~~Millwork and casework.~~
2. ~~Doors and frames.~~
3. ~~Access doors and frames.~~
4. ~~Glazing.~~
5. ~~Metal framing.~~
6. ~~Gypsum board.~~
7. ~~Ceramic tiling.~~
8. ~~Acoustical ceilings.~~
9. ~~Resilient flooring.~~
10. ~~Painting.~~
11. ~~Registers and grilles.~~
12. ~~Wiring devices.~~
13. ~~Lighting.~~
14. ~~<Insert description>.~~

PART 3 - EXECUTION

3.1 TESTING OF INTEGRATED EXTERIOR MOCKUPS

- A. Integrated Exterior Mockup Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
 1. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Integrated Exterior Mockup Testing Services: Perform the following tests in the following order:
 1. Water-Spray Test: Before installation of interior finishes has begun, test areas designated by Architect in accordance with AAMA 501.2 for evidence of water penetration.
 - a. Perform a minimum of [two] [three] <Insert number> tests in areas as directed by Architect.
 2. Air Leakage: Test in accordance with ASTM E783 at 1.5 times the rate specified in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - a. Perform a minimum of [two] [three] <Insert number> tests in areas as directed by Architect.
 3. Water Penetration: Test in accordance with 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 "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and verify no evidence of water penetration.
- C. <Insert testing requirements>.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for the following systems and assemblies.

1. Curtain wall specified in Section 084413 "Glazed Aluminum Curtain Walls."
 2. **<Insert systems and assemblies>.**
- E. Integrated exterior mockup will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.2 TESTING OF PRECONSTRUCTION LABORATORY MOCKUPS

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
1. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Testing Criteria: Where the following tests are indicated, use criteria indicated.
1. Air Leakage in Accordance with ASTM E283: Static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>.**
 2. Water Penetration in Accordance with ASTM E331: Minimum static-air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>.**
- C. Unlock, open, and relock operable windows and doors five times. Perform necessary hardware adjustments, if any, and repeat cycling.
- D. Preconstruction Laboratory Mockup Testing: Perform the following tests in the following order.
1. Structural, 50 Percent: ASTM E330/E330M at 50 percent of positive test load for not less than **[10] <Insert number>** seconds.
 2. Air Leakage: ASTM E283.
 3. Water Penetration under Static Pressure: ASTM E331.
 4. Water Penetration under Dynamic Pressure: AAMA 501.1 at minimum air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>.**
 5. Interstory Drift: AAMA 501.4 at 100 percent of design displacement. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 7. Thermal Cycling: AAMA 501.5. Repeat the following:
 - a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 8. Structural, 100 Percent: ASTM E330/E330M at 100 percent of positive and negative test loads for not less than **[10]**

<Insert number> seconds. Repeat the following:

- a. Air Leakage: ASTM E283.
 - b. Water Penetration under Static Pressure: ASTM E331.
 - c. Water Penetration under Dynamic Pressure: AAMA 501.1.
9. Structural, 150 Percent: ASTM E330/E330M at 150 percent of positive and negative test loads for not less than [10] <Insert number> seconds.
10. Interstory Drift: AAMA 501.4 at 150 percent of design displacement.
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for the following systems and assemblies.
1. Curtain wall specified in Section 084413 "Glazed Aluminum Curtain Wall."
 2. Aluminum windows specified in Section 085113 "Aluminum Windows."
 3. <Insert systems and assemblies>.
- F. Preconstruction laboratory mockup will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

END OF SECTION 014339

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.
 - 2. Section 011200 "Multiple Contract Summary" for responsibilities for temporary facilities and controls for projects utilizing multiple contracts.
 - 3. Section 012100 "Allowances" for allowance for metered use of temporary utilities.

1.2 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities to 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. Sewer Service: [Pay] [Owner will pay] sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: [Pay] [Owner will pay] water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: [Pay] [Owner will pay] electric-power-service use charges for electricity used by all entities for construction operations.
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use [with metering] [without metering and without payment of use charges]. Provide connections and extensions of services [and metering] as required for construction operations.
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use [with metering] [without metering and without payment of use charges]. Provide connections and extensions of services [and metering] as required for construction operations.
- G. Sewer, Water, and Electric Power Service: Use charges are specified in Section 011200 "Multiple Contract Summary."

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. Implementation and Termination Schedule: Within [15] <Insert number> days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- E. Erosion and Sedimentation Control Plan: Show compliance with requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- F. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- G. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. 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 requirements for 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.
- H. 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.
- I. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by Owner. Include the following:
 - 1. Methods used to meet the goals and requirements of Owner.
 - 2. Concrete cutting method(s) to be used.
 - 3. Location of construction devices on the site.
 - 4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
 - 5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with Owner.
 - 6. Indicate locations of sensitive [research] [patient] [equipment] <Insert item> areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

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 DOJ's "2010 ADA Standards for Accessible Design"] [and] [ICC A117.1] <Insert accessibility regulation>.

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 MATERIALS

- A. Chain-Link Fencing: Minimum ~~2-inch, 0.148-inch~~ thick, galvanized-steel, chain-link fabric fencing; minimum ~~6 foot~~ high with galvanized-steel pipe posts; minimum ~~2-3/8-inch~~ OD line posts and ~~2-7/8-inch~~ OD corner and pull posts[, with ~~1-5/8-inch~~ OD top rails] [, with galvanized barbed-wire top strand].
- B. Portable Chain-Link Fencing: Minimum ~~2-inch, 0.148-inch~~ thick, galvanized-steel, chain-link fabric fencing; minimum ~~6 foot~~ high with galvanized-steel pipe posts; minimum ~~2-3/8-inch~~ OD line posts and ~~2-7/8-inch~~ OD corner and pull posts, with ~~1-5/8-inch~~ OD top and bottom rails. Provide ~~[concrete]~~ ~~[galvanized-steel]~~ bases for supporting posts.
- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- D. Wood Enclosure Fence: Plywood, ~~[6 foot]~~ ~~[8 foot]~~ high, framed with four ~~2-by-4-inch~~ rails, with preservative-treated wood posts spaced not more than ~~8 foot~~ apart.
- E. Polyethylene Sheet: Reinforced, fire-resistive sheet, ~~10-mil~~ minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.
- F. Dust-Control Adhesive Surface Walk-Off Mats: Provide mats, minimum ~~36 by 60 inches~~.
- G. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices:
 - 1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
 - 2. Owner will provide conditioned interior space for field offices ~~[for duration of Project]~~ ~~[upon completion of demolition and enclosure]~~.

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] <Insert number> 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.~~

C. ~~Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.~~

- ~~1. Store combustible materials apart from building.~~

2.3 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, Cooling, and Dehumidifying 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] <Insert number> at each return-air grille in system and remove at end of construction[.][and clean HVAC system as required in Section 017700 "Closeout Procedures."]~~

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.
 - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- 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.
- C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed[**in accordance with coordination drawings**].
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

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]** **[private system indicated]** as directed by authorities having jurisdiction.
- C. Water Service:
 - 1. Install water service and distribution piping in sizes and pressures adequate for construction.
 - 2. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash 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.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities **[is not permitted]** **[will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use]**.
- 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. Electric Power Service:

1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
2. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - a. Install electric power service **[overhead]** **[underground]** unless otherwise indicated.
 - b. Connect temporary service to Owner's existing power source, as directed by Owner.

G. 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.

H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install **[WiFi cell phone access equipment]** **[and]** **[one]** **<Insert number>** land-based telephone line(s) for each field office.

1. Provide additional telephone lines for the following:
 - a. Provide **[one]** **<Insert number>** telephone line(s) for Owner's use.
2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. **[Construction Manager's home office]**.
 - g. Engineers' offices.
 - h. Owner's office.
 - i. Principal subcontractors' field and home offices.

I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

J. Project Computer: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:

1. Processor: Intel Core i5 or i7.
2. Memory: **[16]** **<Insert number>** gigabyte.
3. Disk Storage: **[1]** **<Insert number>** -terabyte hard-disk drive and combination DVD-RW/CD-RW drive.
4. Display: **24-inch** LCD monitor with 256-Mb dedicated video RAM.
5. Full-size keyboard and mouse.

6. Network Connectivity: [10/100BaseT Ethernet] [Gigabit].
7. Operating System: Microsoft Windows 10 Professional.
8. Productivity Software:
 - a. Microsoft Office Professional, 2013 or higher, including Word, Excel, and Outlook.
 - b. Adobe Reader DC.
 - c. WinZip 10.0 or higher.
9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
10. Internet Service: Broadband modem, router, and ISP, equipped with hardware firewall, providing minimum [10.0] <Insert number> -Mbps upload and [15] <Insert number> -Mbps download speeds at each computer.
11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
12. Backup: External hard drive, minimum [2] <Insert number> terabytes, with automated backup software providing daily backups.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within **30 feet** of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 2. Utilize designated area within existing building for temporary field offices.
 3. 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] [within construction limits indicated] on Drawings.
 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."
- D. 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.
- E. Parking: **[Provide temporary offsite]** **[Use designated areas of Owner's existing]** parking areas for construction personnel.
- F. Storage and Staging: **[Provide temporary offsite area]** **[Use designated areas of Project site]** for storage and staging needs.
- G. 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.
- H. 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.
- I. Waste Disposal Facilities:
1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
 2. 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."
- J. 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.
- K. Temporary Elevator Use: **[Use of elevators is not permitted]** **[See Division 14 elevator Section for temporary use of new elevators]**.
- L. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
1. Do not load elevators beyond their rated weight capacity.
 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- M. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- N. 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.
0. 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.
 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control:
 1. Comply with **[requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and]** requirements specified in Section 311000 "Site Clearing."
 2. 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, in accordance with **[erosion- and sedimentation-control Drawings]** **[requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent]**.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. 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.
- E. Tree and Plant Protection:
 1. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
 2. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

- G. Site Enclosure Fence: **[Before construction operations begin]** **[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]** **[As indicated on Drawings]**.
 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. **[Furnish one set of keys to Owner.]**
- H. 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.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction **[and requirements indicated on Drawings]**.
1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 2. Paint and maintain appearance of walkway for duration of the Work.
- L. 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.
- M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by **[Owner]** **[and]** **[tenants]** 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. Construct dustproof partitions with two layers of **6-mil** polyethylene sheet on each side. Cover floor with two layers of **6-mil** polyethylene sheet, extending sheets **18 inches** up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than **48 inches** between doors. Maintain water-dampened foot mats in vestibule.
 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air-handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.

- N. 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 in accordance with 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. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- 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.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for [48] <Insert time period> hours are considered defective and require replacing.

- b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for [48] <Insert time period> hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
- c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within [48] <Insert time period> hours.

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. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, 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. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
 - 2. Section 012100 "Allowances" for products selected under an allowance.
 - 3. Section 012300 "Alternates" for products selected under an alternate.
 - 4. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 5. Section 014200 "References" for applicable industry standards for products specified.
 - 6. Section 017700 "Closeout Procedures" for submitting warranties.

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. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, 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. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluating Comparable Products: 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. [**Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.**]
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a

named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 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. Resolution of Compatibility Disputes between Multiple Contractors:
 - a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Architect will determine which products will be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.4 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

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

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections are to 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 standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
 - 2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to 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 in the Project Manual, prepare a written document, using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. **Submittal Time:** Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties 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 Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect ~~through Construction Manager~~ in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.
- 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]~~ **[will not]** 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 that 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."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

- 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] [will not] 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 that 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."~~
 - b. ~~Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.~~
- 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 may additionally 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 the phrase "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 a 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.~~
- E. ~~Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.~~
 - 1. ~~Select products for which sustainable design documentation submittals are available from manufacturer.~~

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 the following 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.~~
 - 2. ~~Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. 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.

3. Evidence that proposed product provides specified warranty.

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

5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within ~~[seven]~~ ~~<Insert number>~~ days of receipt of a request for a comparable product. Architect will notify Contractor ~~[through Construction Manager]~~ of approval or rejection of proposed comparable product within ~~[15]~~ ~~<Insert number>~~ days of receipt of request, or ~~[seven]~~ ~~<Insert number>~~ days of receipt of additional information or documentation, whichever is later.

1. Architect's Approval of Submittal: ~~[Marked with approval notation from Architect's action stamp]~~ ~~[Marked with approval notation from Architect's and Construction Manager's action stamp]~~ ~~[Indication of approval in web-based Project management software]~~ ~~<Insert method>~~. See Section 013300 "Submittal Procedures."

2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

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.
 - 3. Installation.
 - 4. Cutting and patching.
 - 5. Coordination of Owner's portion of the Work.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
 - 9. Correction of the Work.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for coordination of **[Owner-furnished products]** [, **Owner-performed work**] [, **Owner's separate contracts**], and limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.
 - 3. 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.
 - 4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
 - 5. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at **[Project site]** <Insert location>.
 - 1. Prior to **[submitting cutting and patching plan]** **[commencing work requiring cutting and patching]**, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Architect **[and Construction Manager]** of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
 - a. Contractor's superintendent.

- b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.
 - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
 2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- B. Layout Conference: Conduct conference at **[Project site]** **<Insert location>**.
 1. Prior to establishing layout of **[new]** **[new and existing]** perimeter and structural column grid(s), review building location requirements. Review benchmark, control point, and layout and dimension requirements. Inform Architect **[and Construction Manager]** of scheduled meeting. Require representatives of each entity directly concerned with Project layout to attend, including the following:
 - a. Contractor's superintendent.
 - b. **[Professional surveyor]** **[Professional engineer]** **[Contractor's personnel]** responsible for performing Project surveying and layout.
 - c. **[Professional surveyor]** **[Professional engineer]** responsible for performing site survey serving as basis for Project design.
 2. Review meanings and intent of dimensions, notes, terms, graphic symbols, and other layout information indicated on the Drawings.
 3. Review requirements for including layouts on Shop Drawings and other submittals.
 4. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[land surveyor]** **[professional engineer]**.
- B. Certified Surveys: Submit **[two]** **<Insert number>** copies signed by **[land surveyor]** **[professional engineer]**.
- C. Certificates: Submit certificate signed by **[land surveyor]** **[professional engineer]**, certifying that location and elevation of improvements comply with requirements.
- D. Cutting and Patching Plan: Submit plan describing procedures at least **[10]** **<Insert number>** days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

- E. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 CLOSEOUT SUBMITTALS

- A. Final Property Survey: Submit [10] <Insert number> copies showing the Work performed and record survey data.

1.6 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. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- C. 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, or when encountering the need for cutting and patching of elements whose structural function is not known, 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. [**Operational elements include the following:**]
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Plumbing piping systems.
 - f. Mechanical systems piping and ducts.
 - g. Control systems.
 - h. Communication systems.
 - i. Fire-detection and -alarm systems.
 - j. Conveying systems.
 - k. Electrical wiring systems.
 - l. Operating systems of special construction.
 - m. <Insert operating system>.
 - 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. [**Other construction elements include but are not limited to the following:**]
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.

- e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 - h. ~~<Insert miscellaneous element>.~~
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.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 ~~MATERIALS~~

- A. ~~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. Use materials that are not considered hazardous.~~
- C. ~~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.~~
- ~~1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.~~

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, gas service piping, 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. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. 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]** **[Owner]** that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect **[through Construction Manager]** in accordance with 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 and existing conditions. If discrepancies are discovered, notify Architect **[and Construction Manager]** promptly.
- B. Engage a **[land surveyor]** **[professional engineer]** experienced in laying out the Work, using the following 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.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect[**or Construction Manager**]. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect[**and Construction Manager**] before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of **[two]** **<Insert number>** permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- 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]** **[professional engineer]** to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by **[land surveyor]** **[professional engineer]**, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb, and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of [96 inches] <Insert dimension> in occupied spaces and [90 inches] <Insert dimension> in unoccupied spaces, unless otherwise indicated on Drawings.
- 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 satisfactory results as judged by Architect. 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 of type expected for Project.
- 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: 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 with manufacturer.
 - 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, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

- B. 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 in accordance with 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]** **[and]** **[Masonry]**: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable 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, as judged by Architect. 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 eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition 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 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel[**and Owner's separate contractors**].
1. Provide temporary facilities required for Owner-furnished, Contractor-installed[**and Owner-furnished, Owner-installed**] products.
 2. Refer to Section 011000 "Summary" for other requirements for Owner-furnished, Contractor-installed[**and Owner-furnished, Owner-installed**] products.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel[**and Owner's separate contractors**].
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel[**and Owner's separate contractors**] at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. 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, in accordance with 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 in accordance with 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: 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."] [Section 017419 "Construction Waste Management and Disposal."]
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to 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.

3.9 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."

3.10 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.

3.11 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous [~~demolition~~] [~~and~~] [~~construction~~] waste.
 - 2. Recycling nonhazardous [~~demolition~~] [~~and~~] [~~construction~~] waste.
 - 3. Disposing of nonhazardous [~~demolition~~] [~~and~~] [~~construction~~] waste.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for coordination of responsibilities for waste management.
 - 2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
 - 3. Section 044313.13 "Anchored Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
 - 4. Section 044313.16 "Adhered Stone Masonry Veneer" for disposal requirements for excess stone and stone waste.
 - 5. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction 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. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within [7] [30] <Insert number> days of date established for [commencement of the Work] [the Notice to Proceed] [the Notice of Award].

1.5 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use [Form CWM-7 for construction waste] [and] [Form CWM-8 for demolition waste] <Insert Owner's form designation>. Include the following information:
 1. Material category.
 2. Generation point of waste.
 3. Total quantity of waste in **tons**.
 4. Quantity of waste salvaged, both estimated and actual in **tons**.
 5. Quantity of waste recycled, both estimated and actual in **tons**.
 6. Total quantity of waste recovered (salvaged plus recycled) in **tons**.
 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the project's LEED certification application. Document correspondence with USGBC as informational submittals.
- H. Sustainable Design Submittal: Submit documentation to GBI-authorized Assessor signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from GBI-authorized Assessor until GBI-authorized Assessor has made its determination on Project's Green Globes certification application. Document correspondence with GBI-authorized Assessor as informational submittals.
- I. Qualification Data: For [waste management coordinator] [and] [refrigerant recovery technician].
- J. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all

refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

- K. Refrigerant Recovery: Comply with requirements in [Section 024116 "Structure Demolition"] [Section 024119 "Selective Demolition"] for refrigerant recovery submittals.

1.6 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent [may] [may not] serve as Waste Management Coordinator.
1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
 2. Waste management coordinator may also serve as LEED coordinator.
- B. Refrigerant Recovery Technician Qualifications: [Type I] [Type II] [Type III] [Universal] certified by EPA-approved certification program.
- C. Refrigerant Recovery Technician Qualifications: Comply with requirements in [Section 024116 "Structure Demolition."] [Section 024119 "Selective Demolition."]
- D. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- E. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
 2. Review requirements for documenting quantities of each type of waste and its disposition.
 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. [Distinguish between demolition and construction waste.] Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of [demolition] [site-clearing] [and] [construction] waste generated by the Work. Use [Form CWM-1 for construction waste] [and] [Form CWM-2 for demolition waste] <Insert Owner's form designation>. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use [Form CWM-3 for construction waste] [and] [Form CWM-4 for demolition waste] <Insert Owner's form designation>. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with [Section 024116 "Structure Demolition."] [Section 024119 "Selective Demolition."]
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use [Form CWM-5 for construction waste] [and] [Form CWM-6 for demolition waste] <Insert Owner's form designation>. Include the following:
1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in transportation and tipping fees by donating materials.
 7. Savings in transportation and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 ~~RECYCLING RECEIVERS AND PROCESSORS~~

A. ~~Subject to compliance with requirements, available recycling receivers and processors include, but are not limited to, the following:~~

1. ~~<Insert names and telephone numbers of local recycling receivers and processors of recyclable materials>.~~

2.2 ~~PERFORMANCE REQUIREMENTS~~

A. ~~General: Achieve end-of-Project rates for salvage/recycling of [50] [75] <Insert number> percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials[.], including the following:~~

1. ~~Demolition Waste:~~

- a. ~~Asphalt paving.~~

b. — Concrete.
c. — Concrete reinforcing steel.
d. — Brick.
e. — Concrete masonry units.
f. — Wood studs.
g. — Wood joists.
h. — Plywood and oriented strand board.
i. — Wood paneling.
j. — Wood trim.
k. — Structural and miscellaneous steel.
l. — Rough hardware.
m. — Roofing.
n. — Insulation.
o. — Doors and frames.
p. — Door hardware.
q. — Windows.
r. — Glazing.
s. — Metal studs.
t. — Gypsum board.
u. — Acoustical tile and panels.
v. — Carpet.
w. — Carpet pad.
x. — Demountable partitions.
y. — Equipment.
z. — Cabinets.
aa. — Plumbing fixtures.
bb. — Piping.
cc. — Supports and hangers.
dd. — Valves.
ee. — Sprinklers.
ff. — Mechanical equipment.
gg. — Refrigerants.
hh. — Electrical conduit.
ii. — Copper wiring.
jj. — Lighting fixtures.
kk. — Lamps.
ll. — Ballasts.
mm. — Electrical devices.
nn. — Switchgear and panelboards.
oo. — Transformers.
pp. — **<Insert materials required>.**

2. — Construction Waste:

a. — Masonry and CMU.
b. — Lumber.
c. — Wood sheet materials.
d. — Wood trim.
e. — Metals.

- f. ~~Roofing.~~
- g. ~~Insulation.~~
- h. ~~Carpet and pad.~~
- i. ~~Gypsum board.~~
- j. ~~Piping.~~
- k. ~~Electrical conduit.~~
- l. ~~Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:~~

- 1) ~~Paper.~~
- 2) ~~Cardboard.~~
- 3) ~~Boxes.~~
- 4) ~~Plastic sheet and film.~~
- 5) ~~Polystyrene packaging.~~
- 6) ~~Wood crates.~~
- 7) ~~Wood pallets.~~
- 8) ~~Plastic pails.~~

- m. ~~Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:~~

- 1) ~~Paper.~~
- 2) ~~Aluminum cans.~~
- 3) ~~Glass containers.~~

- n. ~~<Insert materials required>.~~

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. [**Coordinator shall be present at Project site full time for duration of Project.**]
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within [three] ~~<Insert number>~~ days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
- E. Waste Management in Historic Zones or Areas: Transportation equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by [12 inches] <Insert dimension> or more.

3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in [Section 024116 "Structure Demolition"] [Section 024119 "Selective Demolition"] [Section 024296 "Historic Removal and Dismantling] for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until installation.
 4. Protect items from damage during transport and storage.
 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for [Sale] [and] [Donation]: [Permitted] [Not permitted] on Project site.
- D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area [on-site] [off-site] [designated by Owner].
 5. Protect items from damage during transport and storage.
- E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- G. Plumbing Fixtures: Separate by type and size.
- H. Lighting Fixtures: Separate lamps by type and protect from breakage.
- I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING [DEMOLITION] [AND] [CONSTRUCTION] WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.

- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall ~~[accrue to Owner]~~ ~~[accrue to Contractor]~~ **[be shared equally by Owner and Contractor]**.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum ~~[1-1/2-inch]~~ **[4-inch]** size.
 - 1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to maximum ~~[1-1/2-inch]~~ **[4-inch]** size.
 - 2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum ~~[3/4-inch]~~ **[1-inch]** ~~[1-1/2-inch]~~ **[4-inch]** size.
 - a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as ~~[general fill]~~ **[satisfactory soil for fill or subbase]**.
 - b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.
 - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

- F. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.
- K. Carpet[**and Pad**]: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet[**and pad**] in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- N. Conduit: Reduce conduit to straight lengths and store by material and size.
- O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
 - 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 - 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.

- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
 - 1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.
- D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.
- D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

3.7 ATTACHMENTS

- A. Form CWM-1 for construction waste identification.
- B. Form CWM-2 for demolition waste identification.
- C. Form CWM-3 for construction waste reduction work plan.
- D. Form CWM-4 for demolition waste reduction work plan.
- E. Form CWM-5 for cost/revenue analysis of construction waste reduction work plan.
- F. Form CWM-6 for cost/revenue analysis of demolition waste reduction work plan.
- G. Form CWM-7 for construction waste reduction progress report.
- H. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 017419

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. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 5. Section 017900 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 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.

1.4 CLOSEOUT SUBMITTALS

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

- C. Field Report: For pest-control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of ~~10~~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 ~~Architect~~Construction Manager. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain ~~Architect's~~Construction Manager'sOwner's signature for receipt of submittals.
 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] <Insert number> 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. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with 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 will 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.
 5. Submit Final Completion photographic documentation.
- 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. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS

- 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], listed by room or space number.
 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect[**and Construction Manager**].
 - d. Name of Contractor.
 - e. Page number.
 4. 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]** <Insert number> Paper Copies: Architect[, **through Construction Manager,**] will return **[two]** <Insert number> copies.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where 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. Partial Occupancy: Submit properly executed warranties within **[15]** <Insert number> days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. 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]** **[by email to Architect]**.
- E. 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.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. 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.~~
 - 1. ~~Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.~~

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 of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.
 - m. Wipe surfaces of mechanical and electrical equipment[, **elevator equipment,**] and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils[**if units were operated without filters during construction or that display contamination with particulate matter on inspection**].
 - 1) Clean HVAC system in compliance with [NADCA ACR.] [Section 230130.52 "Existing HVAC Air-Distribution System Cleaning."] Provide written report on completion of cleaning.
 - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - r. Clean strainers.
 - s. 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."]
[Section 017419 "Construction Waste Management and Disposal."]

3.2 CORRECTION OF THE WORK

- A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
 - 2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 3. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.2 DEFINITIONS

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

1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect **[and Commissioning Authority]** will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit **[on digital media acceptable to Architect] [by uploading to web-based project software site] [by email to Architect]**. Enable reviewer comments on draft submittals.
 - 2. Submit **[three] <Insert number>** paper copies. Architect **[, through Construction Manager,]** will return **[two] <Insert number>** copies.

- C. Initial Manual Submittal: Submit draft copy of each manual at least [30] <Insert number> days before commencing demonstration and training. Architect[**and Commissioning Authority**] will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least [15] <Insert number> days before commencing demonstration and training. Architect[**and Commissioning Authority**] will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's[**and Commissioning Authority's**] comments. Submit copies of each corrected manual within [15] <Insert number> days of receipt of Architect's[**and Commissioning Authority's**] comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, [loose-leaf] [post-type] binders, in thickness necessary to accommodate contents, sized to hold **8-1/2-by-11-inch** paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, [**and**] subject matter of contents[, **and indicate Specification Section number on bottom of spine**]. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 - 4. Supplementary Text: Prepared on **8-1/2-by-11-inch** white bond paper.
 - 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in

rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Architect.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
 - 1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 - 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of

- system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
 1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

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

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

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

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.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 011200 "Multiple Contract Summary" for coordinating Project Record Documents covering the Work of multiple contracts.
 - 2. Section 017300 "Execution" for final property survey.
 - 3. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 4. 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] <Insert number> set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit [one] <Insert number> paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and [one] <Insert number> set(s) of file prints.
 - 3) Submit Record Digital Data Files and [one] <Insert number> set(s) of plots.
 - 4) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit [three] <Insert number> paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned Record Prints and [three] <Insert number> set(s) of file prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal:
 - 1) Submit [one] <Insert number> paper-copy set(s) of marked-up record prints.
 - 2) Submit Record Digital Data Files and [three] <Insert number> set(s) of Record Digital Data File plots.

- 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit [annotated PDF electronic files] [and] <Insert number> [paper copies] of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit [annotated PDF electronic files and directories] [and] <Insert number> [paper copies] 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.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit [annotated PDF electronic files and directories] [and] <Insert number> [paper copies] of each submittal.
- E. Reports: Submit written report [weekly] indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

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] [Work] 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 prints 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 for the original Contract Drawings.
 2. Format: [DWG] [DXF] [DGN], Version <Insert designation>, [Microsoft Windows] [Apple Macintosh] 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] [paper copy] [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] [paper copy] [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 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as [PDF electronic file] [paper copy] [scanned PDF electronic file(s) of marked-up miscellaneous record submittals].
1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.7 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 (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.
- B. Allowances: Furnish demonstration and training instruction time under the demonstration and training allowance as specified in Section 012100 "Allowances."
- C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For [facilitator] [instructor] [videographer].
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit [two] <Insert number> copies within [seven] <Insert number> days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.

- f. Date of video recording.
- 2. Transcript:
 - a. Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
 - b. Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
- 3. At completion of training, submit complete training manual(s) for Owner's use prepared in same [paper] [and] [PDF file] format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

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

1.6 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.

- h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

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

- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner[, **through Architect,**] [, **through Construction Manager,**] with at least **[seven]** **<Insert number>** days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of **[an oral]** **[a written]** **[a demonstration]** performance-based test.
- F. Cleanup: Collect used and leftover educational materials and **[remove from Project site]** **[give to Owner]**. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.9 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of **[12]** **<Insert number>** megapixels and capable of recording in full HD mode **[with vibration reduction technology]**.
 - 1. Submit video recordings **[on CD-ROM or thumb drive]** **[by uploading to web-based Project software site]**.
 - 2. File Hierarchy: Organize folder structure and file locations in accordance with Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 - 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged in accordance with Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration

and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by **[audio narration by microphone while]** **[dubbing audio narration off-site after]** video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 017900

SECTION 030130 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor joint repair.
3. Epoxy crack injection.
- ~~4. Corrosion-inhibiting treatment.~~
- ~~5.4. Polymer overlays.~~
- ~~6.5. Polymer sealers.~~
- ~~7. Composite structural reinforcement.~~

1.2 ALLOWANCES

- A. Allowances for maintenance of cast-in-place concrete are specified in Section 012100 "Allowances."
- B. Field quality-control testing is part of testing and inspecting allowance.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
1. Unit prices apply to authorized work covered by [quantity allowances] [estimated quantities].
 2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.
- B. General: Unit prices include the cost of preparing existing construction to receive the work indicated[and costs of field quality control required for units of work completed].

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
1. Review methods and procedures related to concrete maintenance including, but not limited to, the following:
 - a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.
 - d. Coordination with building occupants.
 - e. <Insert agenda items>.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
- B. Samples: Cured Samples for each exposed product and for each color and texture specified, **[in manufacturer's standard size appropriate for each type of work]** **<Insert requirements or dimensions>**.
- C. Samples for Initial Selection: Cured Samples for each exposed product and for each color and texture.
 - 1. Include sets of patching-material Samples in the form of briquettes, at least **[3 inches long by 1-1/2 inches wide]** **<Insert dimensions>** representative of the range of concrete colors on the building. Document each Sample with product, mix, and or other information necessary to replicate it.
 - 2. Include sets of Samples for epoxy crack-injection adhesive and capping adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
 - 3. Include sets of polymer-overlay Samples in the form of treated cementitious tiles at least **[4 inches long by 4 inches wide]** **<Insert dimensions>** representative of the range of required colors and textures.
 - 4. Include sets of polymer-sealer Samples in the form of treated cementitious tiles at least **[4 inches long by 4 inches wide]** **<Insert dimensions>** representative of the range of required colors and textures.
 - 5. Have each set of Samples contain a close color range of at least **[three]** **[six]** **<Insert number>** Samples of different mixes of materials that match the variations in existing, adjacent concrete when cured and dry.
- D. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.
 - 1. Include Samples of each required type, color, and texture of patching material in the form of patches in drilled holes or sawed joints in sample concrete representative of the range of concrete colors on the building.
 - 2. Include Samples of epoxy crack-injection in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.
 - 3. Include Samples of each required type, color, and texture of polymer-overlay material in the form of cementitious tiles at least **[8 inches long by 8 inches wide]** **<Insert dimensions>**.
 - 4. Include Samples of each required type, color, and texture of polymer-sealer material in the form of cementitious tiles at least **[8 inches long by 8 inches wide]** **<Insert dimensions>**.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[concrete-maintenance specialist]** **[and]** **[manufacturers]**.
- B. Material Certificates: For each type of **[portland cement]** **[aggregate]** **<Insert material>** supplied for mixing or adding to products at Project site.
- C. Product Test Reports: For each **[manufactured bonding agent]** **[cementitious patching mortar]** **[joint-filler]** **[crack-injection adhesive]** **[polymer overlay]** **[polymer sealer]** **[and]** **[composite structural reinforcement]** **<Insert product>**, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Field quality-control reports.
- E. Quality-Control Program: Submit before work begins.

1.7 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** Each [~~manufactured bonding-agent~~] [~~packaged patching-mortar~~] [~~joint-filler~~] [~~crack-injection-adhesive~~] [~~corrosion-inhibiting-treatment~~] [~~polymer-overlay~~] [~~polymer-sealer~~] [~~and~~] [~~composite-structural-reinforcement~~] <Insert product> manufacturer shall employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.
- B. **Concrete-Maintenance Specialist Qualifications:** Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply [~~packaged patching-mortar~~] [~~crack-injection adhesive~~] [~~corrosion-inhibiting treatments~~] [~~polymer overlays~~] [~~polymer sealers~~] [~~and~~] [~~composite structural reinforcement~~] <Insert product> to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.
 - 1. **Field Supervision:** Concrete-maintenance specialist firm shall maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.
- C. **Quality-Control Program:** Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
- D. **Mockups:** Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. **Concrete Removal and Patching:** Remove and repair an [~~approximately 50 sq. ft.~~] [~~approximately 100 sq. in.~~] <Insert dimension> area of [~~deteriorated concrete deck~~] [~~deteriorated concrete wall~~] <Insert description>.
 - 2. **Floor Joint Repair:** Cut out and reinstall joints in two separate areas [, ~~each approximately 48 inches long~~] [as indicated on Drawings] <Insert dimension>.
 - 3. **Epoxy Crack Injection:** Perform epoxy crack injection in two separate areas [, ~~each approximately 48 inches long~~] [as indicated on Drawings] <Insert dimension>.
 - 4. **Polymer Overlay:** Apply an [~~approximately 50 sq. ft.~~] <Insert dimension> area of polymer overlay.
 - 5. **Polymer Sealer:** Apply an [~~approximately 50 sq. ft.~~] <Insert dimension> area of polymer sealer.
 - 6. **Composite Structural Reinforcement:** Apply composite structural reinforcement [~~a minimum of 48 inches long~~] [as indicated on Drawings] <Insert dimension>.
 - 7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
- B. Store cementitious materials off the ground, under cover, and in a dry location.
- C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.9 FIELD CONDITIONS

- A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.
1. Use only Class A epoxies when substrate temperatures are below or are expected to go below **40 deg F** within eight hours.
 2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below **60 deg F** within eight hours.
 3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above **60 deg F** for eight hours.
- B. Cold-Weather Requirements for Cementitious Materials:
1. Do not apply unless concrete-surface and air temperatures are above **40 deg F** and will remain so for at least 48 hours after completion of Work.
 2. Comply with the following procedures:
 - a. When air temperature is below **40 deg F**, heat patching-material ingredients and existing concrete to produce temperatures between **40 and 90 deg F**.
 - b. When mean daily air temperature is between **25 and 40 deg F**, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above **32 deg F** within the enclosure for 48 hours after repair.
 - c. When mean daily air temperature is below **25 deg F**, provide enclosure and heat to maintain temperatures above **32 deg F** within the enclosure for 48 hours after repair.
- C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of **90 deg F** and above.
- D. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below **55 deg F** or above **[75 deg F] [90 deg F] <Insert temperature>**. Apply only to **[dry substrates] [substrates that have been dry for at least 72 hours]**.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 ~~BONDING AGENTS~~

- A. ~~Mortar Scrub Coat: Mix consisting of 1 part portland cement and 1 part fine aggregate complying with ASTM C144 except 100 percent passing a No. 16 sieve.~~

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar [where indicated] that matches existing, adjacent, exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, washed aggregate, Size No. 8, Class 5S. Add to patching mortar mix only as permitted by patching mortar manufacturer.

B. Job-Mixed Patching Mortar <Insert drawing designation>: 1 part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a No. 16 sieve.

2.42.2 PREPLACED CONCRETE MATERIALS

- A. Preplaced Aggregate: Washed aggregate, ASTM C33/C33M, Class 5S, with [95 to 100 percent passing a 1-1/2-inch sieve, 40 to 80 percent passing a 1-inch sieve, 20 to 45 percent passing a 3/4-inch sieve, zero to 10 percent passing a 1/2-inch sieve, and zero to 2 percent passing a 3/8-inch sieve] [100 percent passing a 1-1/2-inch sieve, 95 to 100 percent passing a 1-inch sieve, 40 to 80 percent passing a 3/4-inch sieve, zero to 15 percent passing a 1/2-inch sieve, and zero to 2 percent passing a 3/8-inch sieve] <Insert requirement>.
- B. Fine Aggregate for Grout: Fine aggregate according to ASTM C33/C33M, but with 100 percent passing a No. 8 sieve, 95 to 100 percent passing a No. 16 sieve, 55 to 80 percent passing a No. 30 sieve, 30 to 55 percent passing a No. 50 sieve, 10 to 30 percent passing a No. 100 sieve, zero to 10 percent passing a No. 200 sieve, and having a fineness modulus of 1.30 to 2.10.
- C. Grout Fluidifier for Grout: ASTM C937.
- D. Pozzolans for Grout: ASTM C618.

2.5 JOINT FILLER

- A. Color: [As indicated by manufacturer's designations] [Matching existing joint filler] [As selected by Architect from full range of industry colors] <Insert requirement>.

2.62.3 MISCELLANEOUS MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.
- B. Water: Potable.

2.72.4 MIXES

- A. General: Mix products, in clean containers, according to manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
 2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
 3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.
- B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.
- C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
- D. Concrete: Comply with [Section 033000 "Cast-in-Place Concrete."] [Section 033300 "Architectural Concrete."]
- E. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

PART 3 - EXECUTION

3.1 CONCRETE-MAINTENANCE SPECIALIST

- A. Concrete-Maintenance Specialist Firms: Subject to compliance with requirements, **[have concrete maintenance performed by one of the following] [firms that may perform concrete maintenance include, but are not limited to, the following]:**
1. **<Insert, in separate subparagraphs, names of concrete-maintenance specialist firms>.**

3.2 CONCRETE MAINTENANCE

- A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.
- B. Comply with manufacturers' written instructions for surface preparation and product application.

3.3 EXAMINATION

- A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
- B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb unless otherwise indicated.
- C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.
- D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.4 PREPARATION

- A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.
- B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete maintenance work.
 - 1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
 - 2. Use only proven protection methods appropriate to each area and surface being protected.
 - 3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete maintenance work is being performed.
 - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete maintenance work.
 - 5. Contain dust and debris generated by concrete maintenance work and prevent it from reaching the public or adjacent surfaces.
 - 6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
 - 7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
 - 8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
 - 9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape [**or a liquid strippable masking agent**]. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
 - 10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
 - 11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- C. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is in working order.
 - 1. Prevent solids such as aggregate or mortar residue from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete maintenance work.
 - 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.
 - 1. Verify that affected utilities have been disconnected and capped.
 - 2. Inventory and record the condition of items to be removed for reinstallation or salvage.
 - 3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.
- E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by **[high-pressure water cleaning] [abrasive blast cleaning] [needle scaling] [or] [wire brushing]** until only tightly adhered light rust remains.
 - 1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.

2. Remove additional concrete as necessary to provide at least **3/4-inch** clearance at existing and replacement bars.
 3. Splice replacement bars to existing bars according to **ACI 318** by lapping, welding, or using mechanical couplings.
- F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than **[3/4 inch] [1 inch] [2 inches]** **<Insert dimension>** deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
- G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.
1. Use **[low-pressure water cleaning] [detergent scrubbing] [or] [sand blasting]** **<Insert requirement>**.
 2. Allow surface to dry before applying corrosion-inhibiting treatment.
- H. Surface Preparation for Overlays:
1. Remove delaminated material and deteriorated concrete surface material.
 2. Roughen surface of concrete to produce a surface profile matching CSP **[3] [4] [5] [6] [7] [8] [9]** according to ICRI 310.2.
 3. Use **[sand blasting] [shot blasting] [scarifying] [needle scaling] [high-pressure water jetting] [scabbling] [flame blasting] [or] [milling]** **<Insert requirement>**.
 4. Sweep and vacuum roughened surface to remove debris **[followed by low-pressure water cleaning]**.
- I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 according to ICRI 310.2. **[Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.]**
1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
 2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
 3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable according to sealer manufacturer's written instructions.
 4. When pH is acceptable according to sealer manufacturer's written instructions and surface is clean, vacuum dry.
- J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.
1. Use **[shot blasting] [low-pressure water cleaning] [or] [detergent scrubbing]** **<Insert requirement>**.
- K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by **[low-pressure water cleaning] [or] [detergent scrubbing]** **<Insert requirement>** to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.
1. Roughen surface of concrete by sand blasting.
 2. Remove delaminated material and deteriorated concrete surface material.
 3. Sweep and vacuum roughened surface to remove debris **[followed by low-pressure water cleaning]**.
- 3.5 REMOVAL OF CONCRETE
- A. Do not overload structural elements with debris.
- B. Saw-cut perimeter of areas indicated for removal to a depth of at least **[1/2 inch]** **<Insert dimension>**. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

- C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
- D. Remove additional concrete if necessary to provide a depth of removal of at least **1/2 inch** <Insert dimension> over entire removal area.
- E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least **3/4-inch** clearance around bar.
- F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
- G. Provide surfaces with a fractured profile of at least **1/8 inch** that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.
- H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.6 APPLICATION OF BONDING AGENT

- A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars **[and concrete]** by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
- B. Epoxy Bonding Agent: Apply to reinforcing bars **[and concrete]** by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. **[Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat.]** Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
- C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
- D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
- E. Mortar Scrub Coat for Job-Mixed Patching Mortar **[and Concrete]**: Dampen repair area and surrounding concrete **6 inches** beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.
- F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar **[mixed with latex bonding agent]** into substrate, filling pores and voids.

3.7 ~~INSTALLATION OF PATCHING MORTAR~~

- A. ~~Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer [or where dry-pack mortar is indicated].~~
 - 1. ~~Provide forms where necessary to confine patch to required shape.~~
 - 2. ~~Wet substrate and forms thoroughly and then remove standing water.~~

- B. ~~Pretreatment: Apply specified [bonding agent] [mortar scrub coat] [slurry coat] [bonding agent and slurry coat] <Insert requirement>.~~
- C. ~~General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.~~
- D. ~~Vertical Patching: Place material in lifts of not more than [1 inch] [1-1/2 inches] [2 inches] [3 inches] or less than [1/8 inch] [1/4 inch]. Do not feather edge.~~
- E. ~~Overhead Patching: Place material in lifts of not more than [1 inch] [1-1/2 inches] [2 inches] or less than [1/8 inch] [1/4 inch]. Do not feather edge.~~
- F. ~~Consolidation: After each lift is placed, consolidate material and screed surface.~~
- G. ~~Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.~~
- H. ~~Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a [smooth surface with a wood or sponge float] [rough surface with a broom or burlap drag] [surface matching adjacent concrete] <Insert requirement>.~~
- I. ~~Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.~~

3.83.7 INSTALLATION OF DRY-PACK-MORTAR

- A. Use dry-pack mortar for deep cavities[**and where indicated**]. Place as specified in this article unless otherwise recommended in writing by manufacturer.
 - 1. Provide forms where necessary to confine patch to required shape.
 - 2. Wet substrate and forms thoroughly and then remove standing water.
- B. Pretreatment: Apply specified [bonding agent] [mortar scrub coat] [slurry coat] [bonding agent and slurry coat] <Insert requirement>.
- C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
- D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
- E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.93.8 CONCRETE PLACEMENT

- A. Place concrete according to [Section 033000 "Cast-in-Place Concrete"] [Section 033300 "Architectural Concrete"] and as specified in this article.

- B. Epoxy-Modified Pretreatment: Apply [epoxy-modified, cementitious bonding and anticorrosion agent] [epoxy bonding agent] <Insert requirement> to reinforcement[and concrete substrate].
- C. Latex Pretreatment: Apply [latex bonding agent] [Type I latex bonding agent] [mortar scrub coat] <Insert requirement> to concrete substrate.
- D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.
 - 1. Use vibrators to consolidate concrete as it is placed.
 - 2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
- E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.
 - 1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
 - 2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to **14 psi**.
- F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
- G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.103.9 GROUTING PREPLACED AGGREGATE CONCRETE

- A. Use grouted preplaced aggregate concrete [where indicated] [for column and wall repairs] <Insert requirement>. Place as specified in this article.
- B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.
- C. Apply [epoxy-modified cementitious bonding and anticorrosion agent] [epoxy bonding agent] to reinforcement[and concrete substrate].
- D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
- E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.
- F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to **14 psi**.
- G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
- H. Repair voids with patching mortar and finish to match surrounding concrete.

3.113.10 FLOOR-JOINT REPAIR

- A. Cut out deteriorated concrete [**and reconstruct sides of joint with patching mortar**] **<Insert requirement>** as indicated on Drawings. Install joint filler in nonmoving floor joints where indicated and as specified in this article.
- B. Depth: Install joint filler to a depth of at least [**3/4 inch**] [**1 inch**] [**2 inches**] **<Insert dimension>**. Use fine silica sand no more than **1/4 inch** deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
- C. Top Surface: Install joint filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

3.123.11 EPOXY CRACK INJECTION

- A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
- B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.
- C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
- D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least **1/4 inch** thick by **1 inch** wider than crack.
- E. Inject cracks wider than **0.003 inch** to a depth of **8 inches**.
- F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
- G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.133.12 APPLICATION OF CORROSION-INHIBITING-TREATMENT

- A. Apply corrosion-inhibiting treatment to [**surfaces indicated on Drawings, from wall-to-wall or curb-to-curb and from joint-to-joint in the perpendicular direction**] **<Insert locations and extent where treatment shall be applied>**.
- B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete[**or applying a sealer or overlay**].

3.143.13 APPLICATION OF POLYMER OVERLAY

- A. Apply polymer overlay according to ACI 503.3.
- B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.153.14 APPLICATION OF POLYMER SEALER

- A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

- B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.163.15 INSTALLATION OF COMPOSITE STRUCTURAL REINFORCEMENT

- A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:
1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
 2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
 3. Apply epoxy saturant to **[fiber tow sheet]** **[or]** **[primed and patched surface]** using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.
 4. Apply additional layers using same procedure, fully saturating each layer with epoxy.
 5. After saturant has cured, apply protective topcoat by **[brush]** **[roller]** **[or]** **[spray]**.
- B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:
1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
 2. Apply epoxy adhesive to a thickness of **1/16 inch** to prepared concrete surfaces.
 3. Clean fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of **1/16 inch**.
 4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
 5. Apply additional layers using same procedure.

3.173.16 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
1. Packaged, Cementitious Patching Mortar: **<Insert number>** randomly selected sets of samples for each type of mortar required, tested according to ASTM C928/C928M.
 2. Job-Mixed Patching Mortar: **<Insert number>** randomly selected sets of samples for each type of mortar required, tested for compressive strength according to ASTM C109/C109M.
 3. Concrete: As specified in **[Section 033000 "Cast-in-Place Concrete."]** **[Section 033300 "Architectural Concrete."]**
 4. Grout for Preplaced Aggregate: Tested for compressive strength according to ASTM C942.
 - a. Testing Frequency: One sample for each **25 cu. yd.** of grout or fraction thereof, but not less than one sample for each day's work.
 5. Joint Filler: Core-drilled samples to verify proper installation.
 - a. Testing Frequency: One sample for each **100 feet** of joint filled.
 - b. Where samples are taken, refill holes with joint filler.
 6. Epoxy Crack Injection: Core-drilled samples to verify proper installation.
 - a. Testing Frequency: **[Three samples from mockup and]** one sample for each **100 feet** of crack injected.

- b. Where samples are taken, refill holes with epoxy mortar.
- C. Product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.
- 1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:
 - a. Bonding-Agent and Packaged Patching-Mortar Installation: [Three] <Insert number> inspections.
 - b. Joint-Filler Installation: [Two] <Insert number> inspections.
 - c. Crack-Injection-Adhesive Preparation and Installation: [Four] <Insert number> inspections.
 - d. Corrosion-Inhibiting Treatment: [Two] <Insert number> inspections.
 - e. Polymer Overlay: [Two] <Insert number> inspections.
 - f. Polymer Sealer: [Two] <Insert number> inspections.
 - g. Composite-Structural-Reinforcement: [Three] <Insert number> inspections.

3.183.17 CONCRETE MAINTENANCE SCHEDULE

- A. Garage Level 1 Entrance Ramp: Perform the following as indicated on Drawings:
 - 1. Removal of deteriorated concrete and subsequent replacement and patching.
 - 2. Floor joint repair.
 - 3. Epoxy crack injection.
 - 4. Corrosion-inhibiting treatment.
 - 5. Polymer overlays.
 - 6. Polymer sealers.
 - 7. Composite structural reinforcement on underside of slab.
- B. Elevated Warehouse Floors: Perform the following as indicated on Drawings:
 - 1. Removal of deteriorated concrete and subsequent replacement and patching.
 - 2. Floor joint repair.
 - 3. Epoxy crack injection.
 - 4. Corrosion-inhibiting treatment.
 - 5. Polymer overlays.
 - 6. Polymer sealers.
 - 7. Composite structural reinforcement on underside of slab.
- C. Concrete Walls and Floor in Salt Dome: Perform the following as indicated on Drawings:
 - 1. Removal of deteriorated concrete and subsequent replacement and patching.
 - 2. Floor joint repair.
 - 3. Epoxy crack injection.
 - 4. Corrosion-inhibiting treatment.

5. Polymer overlays.
6. Polymer sealers.
7. Composite structural reinforcement of columns.

END OF SECTION 030130

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
- ~~2. Form liners.~~
- ~~3. Insulating concrete forms.~~
- ~~4-2.~~ Shoring, bracing, and anchoring.

~~B. Related Requirements:~~

- ~~1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.~~
- ~~2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.~~

1.2 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction, movement, contraction, and isolation joints
 - c. Forms and form-removal limitations.
 - d. Shoring and reshoring procedures.
 - e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.

3. Forms for cylindrical columns.
4. Pan-type forms.
5. Void forms.
6. Form liners.
7. Insulating concrete forms.
8. Form ties.
9. Waterstops.
10. Form-release agent.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Laboratory Test Reports: For **[liquid floor treatments]** **[and]** **[curing and sealing compounds]**, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with **ACI 301**.
 - a. Location of construction joints is subject to approval of the Architect.
3. Indicate location of waterstops.
4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

D. Samples:

1. For waterstops.
2. For Form Liners: **12-inch by 12-inch** sample, indicating texture.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC308.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, [**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
 - 1. Build panel approximately [**100 sq. ft.**] <Insert area> in the location indicated or, if not indicated, as directed by Architect.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.
- B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with **ACI 301**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
 - 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
 - 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
 - a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with **ACI 301**, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
 - a. Wind Loads: As indicated on Drawings.
 - 1) Horizontal Deflection Limit: Not more than [1/240] [1/360] [1/600] [1/720] <Insert ratio> of the wall height.

2.2 ~~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 033000 "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, and as follows:~~
 - 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.~~

C. ~~Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces [with gradual or abrupt irregularities] [without spiral or vertical seams] not exceeding specified formwork surface class.~~

1. ~~Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.~~

D. ~~Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with [straight] [or] [tapered] end forms.~~

E. ~~Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.~~

2.3 ~~INSULATING CONCRETE FORMS~~

A. ~~Recycled Content of Insulation: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

1. ~~Cross Ties: Polypropylene, with integral reinforcement supports, designed to allow passage of concrete during placement.~~
2. ~~Core Thickness: [4 inches] [6 inches] [8 inches] [10 inches] [12 inches].~~

2.42.2 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than **0.022-inch** 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** 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**, 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.
 - 1. Furnish units that leave no corrodible metal closer than **1 inch** to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, leave holes no larger than **1 inch** in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with **ACI 301**.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of **ACI 117** and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes [and] [Section 033300 "Architectural Concrete"].
- C. Limit concrete surface irregularities as follows:
 - 1. Surface Finish-1.0: ACI 117 Class D, **1 inch**.
 - 2. Surface Finish-2.0: ACI 117 Class B, **1/4 inch**.
 - 3. Surface Finish-3.0: ACI 117 Class A, **1/8 inch**.
- 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. [Chamfer] [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**.
- 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 [as indicated on Drawings] <Insert 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.

3.2 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.

3.3 ~~INSTALLATION OF WATERSTOPS~~

- A. ~~Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.~~
 - 1. ~~Install in longest lengths practicable.~~
 - 2. ~~Locate waterstops in center of joint unless otherwise indicated on Drawings.~~
 - 3. ~~Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."~~
 - 4. ~~Secure waterstops in correct position at 12 inches on center.~~
 - 5. ~~Field fabricate joints in accordance with manufacturer's instructions using heat welding.~~
 - a. ~~Miter corners, intersections, and directional changes in waterstops.~~
 - b. ~~Align center bulbs.~~
 - 6. ~~Clean waterstops immediately prior to placement of concrete.~~
 - 7. ~~Support and protect exposed waterstops during progress of the Work.~~
- B. ~~Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.~~
 - 1. ~~Install in longest lengths practicable.~~
 - 2. ~~Locate waterstops in center of joint unless otherwise indicated on Drawings.~~
 - 3. ~~Protect exposed waterstops during progress of the Work.~~

3.4 ~~INSTALLATION OF INSULATING CONCRETE FORMS~~

- A. ~~Comply with ACI 301 and manufacturer's instructions.~~
- B. ~~Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.~~

- C. ~~Install forms in running bond pattern.~~
 - 1. ~~Align joints.~~
 - 2. ~~Align furring strips.~~
- D. ~~Construct forms tight to prevent loss of concrete mortar.~~
- E. ~~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.~~
- F. ~~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.~~
- G. ~~Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.~~
- H. ~~Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.~~
- I. ~~Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.~~

3.53.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F** for [24] <Insert number> hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved [**at least 70 percent of**] its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
 - 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 - 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
 - 1. Align and secure joints to avoid offsets.
 - 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.63.4 SHORING AND RESHORING INSTALLATION

- A. Comply with **ACI 318** and **ACI 301** for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.73.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a [special inspector] [and] [qualified testing and inspecting agency] to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction contraction and isolation joints.
 - c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.
5. Mechanical splice couplers.
6. Structural thermal break insulated connection system.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Type III Environmental Product Declaration (EPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
13. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

C. 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.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

E. Delegated Design Submittal: For structural thermal break insulated connection system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For **[delegated design engineer]** **[testing and inspection agency]**.

B. Delegated Design Engineer Qualifications: Include the following:

1. Experience providing delegated design engineering services of the type indicated.
2. Documentation that delegated design engineer is licensed in the **[jurisdiction]** **[state]** in which Project is located.

C. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

D. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

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

1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
2. Mechanical splice couplers.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, [**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.
- C. Mockups: Reinforcing for cast-concrete formed surfaces, to demonstrate tolerances and standard of workmanship.
 1. Build panel approximately [**100 sq. ft. for formed surface**] <Insert area> in the location indicated on Drawings or, if not indicated, as directed by Architect.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage [**and to avoid damaging coatings on steel reinforcement**].
 1. Store reinforcement to avoid contact with earth.
 2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
 4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design structural thermal break insulated connection system, including attachment to building construction.
- B. Structural Performance of Structural Thermal Break Insulating Connection System: Structural thermal break insulated connection system to withstand the following loads and stresses:

1. Dead Loads: As indicated on Drawings.
 - a. Shear Load: As indicated on Drawings.
 - b. Bending Moment: As indicated on Drawings.
2. Live Loads: As indicated on Drawings.
 - a. Shear Load: As indicated on Drawings.
 - b. Bending Moment: As indicated on Drawings.
- C. Seismic Performance of Structural Thermal Break Insulated Connection System: Structural thermal break Insulated connection system to withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 1. Component Importance Factor: <Insert requirement>.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
 1. Regional Materials: Steel shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
 2. Regional Materials: Steel shall be manufactured within **500 miles** of Project site.
 3. Regional Materials: Steel shall be manufactured within **100 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
 4. Indigenous Materials: Steel shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
 5. Regional Materials: Steel shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- B. Reinforcing Bars: ASTM A615/A615M, [**Grade 60**] [**Grade 75**] [**Grade 80**] [**Grade 100**], deformed.
- C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- D. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- E. Galvanized Reinforcing Bars:
 1. Steel Bars: [ASTM A615/A615M, **Grade 60**] [ASTM A615/A615M, **Grade 75**] [ASTM A615/A615M, **Grade 80**] [ASTM A615/A615M, **Grade 100**] [ASTM A706/A706M], deformed bars.
 2. Zinc Coating: ASTM A767/A767M, [**Class I**] [**Class II**] zinc coated after fabrication and bending.
- F. Epoxy-Coated Reinforcing Bars:
 1. Steel Bars: [ASTM A615/A615M, **Grade 60**] [ASTM A615/A615M, **Grade 75**] [ASTM A615/A615M, **Grade 80**] [ASTM A615/A615M, **Grade 100**] [ASTM A706/A706M], deformed bars.
 2. Epoxy Coating: [ASTM A775/A775M] [or] [ASTM A934/A934M] with less than 2 percent damaged coating in each **12-**

~~inch~~ bar length.

- G. Dual-Coated Reinforcing Bars: ASTM A1055/A1055M.
1. Steel Bars: [ASTM A615/A615M, ~~Grade 60~~] [ASTM A615/A615M, ~~Grade 75~~] [ASTM A615/A615M, ~~Grade 80~~] [ASTM A615/A615M, ~~Grade 100~~] [ASTM A706/A706M], deformed bars.
 2. Zinc Coating: ASTM A1055/A1055M [Type I] [Type II].
 3. Epoxy Coating: [ASTM A775/A775M] [or] [ASTM A934/A934M] with less than 2 percent damaged coating in each ~~12-inch~~ bar length.
- H. Stainless Steel Reinforcing Bars: ASTM A955/A955M, [~~Grade 60~~] [~~Grade 75~~], [Type 304] [Type 316L], deformed.
- I. Steel Bar Mats: ASTM A184/A184M, fabricated from [ASTM A615/A615M, ~~Grade 60~~] [ASTM A615/A615M, ~~Grade 40~~] [ASTM A706/A706M], deformed bars, assembled with clips.
- J. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- K. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- L. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
- M. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, [~~plain~~] [~~deformed~~] steel.

2.3 REINFORCEMENT ACCESSORIES

- A. ~~Joint Dowel Bars: ASTM A615/A615M, ~~Grade 60~~, plain-steel bars, cut true to length with ends square and free of burrs.~~
- B. ~~Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, ~~Grade 60~~, plain-steel bars, ASTM A775/A775M epoxy coated.~~
- C. ~~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.~~
 - ~~b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.~~
 - ~~c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.~~
 - ~~d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.~~
 - ~~e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.~~
- D. ~~Mechanical Splice Couplers: ~~ACI 318~~ [Type 1] [Type 2], same material of reinforcing bar being spliced; [~~compression-only type~~] [~~tension-compression type~~] [~~dowel bar type~~] [~~mechanical lap type~~].~~
- E. ~~Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than ~~0.0508 inch~~ in diameter.~~
- ~~1. Finish: [~~Plain~~] [~~Galvanized~~] [~~ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating~~]~~

~~in each 12-inch wire length].~~

~~F. — Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than 0.0508 inch in diameter.~~

~~G. — Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.~~

~~H. — Zinc Repair Material: ASTM A780/A780M.~~

2.42.3 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, 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.
- 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 to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
 2. Stagger splices in accordance with ACI 318.
 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.

4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.
- H. Install welded-wire reinforcement in longest practicable lengths.
 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed **12 inches**.
 2. Lap edges and ends of adjoining sheets at least one wire spacing plus **2 inches** for plain wire and **8 inches** for deformed wire.
 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 4. Lace overlaps with wire.
- I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.
- J. Dual-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.
- K. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material in accordance with ASTM A780/A780M.

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.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with **ACI 117**.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a [special inspector] [and] [qualified testing and inspecting agency] to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Steel-reinforcement placement.

2. Steel-reinforcement mechanical splice couplers.
 3. Steel-reinforcement welding.
- D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 035300 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 321313 "Concrete Paving" for concrete pavement and walks.
8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. 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] <Insert location>.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special concrete finish Subcontractor.
2. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction joints, control joints, isolation joints, and joint-filler strips.

- c. Semirigid joint fillers.
- d. Vapor-retarder installation.
- e. Anchor rod and anchorage device installation tolerances.
- f. Cold and hot weather concreting procedures.
- g. Concrete finishes and finishing.
- h. Curing procedures.
- i. Forms and form-removal limitations.
- j. Shoring and reshoring procedures.
- k. Methods for achieving specified floor and slab flatness and levelness.
- l. Floor and slab flatness and levelness measurements.
- m. Concrete repair procedures.
- n. Concrete protection.
- o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
- p. Protection of field cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

- 1. Portland cement.
- 2. Fly ash.
- 3. Slag cement.
- 4. Blended hydraulic cement.
- 5. Silica fume.
- 6. Performance-based hydraulic cement
- 7. Aggregates.
- 8. 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.

- 9. Color pigments.
- 10. Fiber reinforcement.
- 11. Vapor retarders.
- 12. Floor and slab treatments.
- 13. Liquid floor treatments.
- 14. Curing materials.

- a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

- 15. Joint fillers.
- 16. Repair materials.

B. Sustainable Design Submittals:

- 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 3. Environmental Product Declaration (EPD): For each product.
 4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
 5. Environmental Product Declaration: For each product.
 6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
 7. Environmental Product Declaration: For each product.
 8. Environmental Product Declaration: For each product.
 9. Third-Party Certifications: For each product.
 10. Third-Party Certified Life Cycle Assessment: For each product.
 11. Laboratory Test Reports: For [liquid floor treatments] [and] [curing and sealing compounds], indicating compliance with requirements for low-emitting materials.
 12. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:
 - a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
 - b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
 - c. Third-party-verified Declare product label, designated "Red List Free."
 - d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.
- C. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Durability exposure class.
 4. Maximum w/cm.
 5. Calculated equilibrium unit weight, for lightweight concrete.
 6. Slump limit.
 7. Air content.
 8. Nominal maximum aggregate size.
 9. Steel-fiber reinforcement content.
 10. Synthetic micro-fiber content.
 11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
 12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
 13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
 14. Intended placement method.
 15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.
- E. Samples: For [manufacturer's standard colors for color pigment] [vapor retarder] <Insert products>.

F. 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. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

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

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.
8. Admixtures:

- a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

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

- E. Research Reports:
 - 1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
 - 2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.
- F. Preconstruction Test Reports: For each mix design.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician **[with experience installing and finishing concrete, incorporating permeability-reducing admixtures]**.
 - 1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. 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."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
 - 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, **[acceptable to authorities having jurisdiction,]** qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.
- E. Mockups: Cast concrete **[slab-on-ground]** **[and]** **[formed-surface]** panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
 - 1. Slab-On-Ground: Build panel approximately **15 feet by 15 feet** **<Insert area>** in the location indicated or, if not indicated, as directed by Architect.
 - a. Divide panel into four equal panels to demonstrate saw joint cutting.
 - 2. Formed Surfaces: Build panel approximately **100 sq. ft.** **<Insert area>** in the location indicated or, if not indicated, as directed by Architect.
 - 3. 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 each concrete mixture.
 - 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.
 - f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and **ACI 301**.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with **ACI 301** and ACI 306.1 and as follows.
 - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 2. When average high and low temperature is expected to fall below **40 deg F** for three successive days, maintain delivered concrete mixture temperature within the temperature range required by **ACI 301**.
 - 3. Do not use frozen materials or materials containing ice or snow.
 - 4. Do not place concrete in contact with surfaces less than **35 deg F**, other than reinforcing steel.
 - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with **ACI 301** and **ACI 305.1**, and as follows:
 - 1. Maintain concrete temperature at time of discharge to not exceed **95 deg F**.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates [**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- B. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site.
- C. Regional Materials: Concrete shall be manufactured within **100 miles** of Project site from aggregates [**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- D. Indigenous Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates [**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- E. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates [**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Source Limitations:
1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 3. Obtain aggregate from single source.
 4. Obtain each type of admixture from single source from single manufacturer.
- G. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**], [**gray**] [**white**].
 2. Fly Ash: ASTM C618, Class C or F.
 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
 4. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, portland-limestone**] [**Type IT, ternary blended**] cement.
 5. Silica Fume: ASTM C1240 amorphous silica.
 6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [**Type GU, general use**] [**Type HE, high early strength**] [**Type MS, moderate sulfate resistance**] [**Type HS, high sulfate resistance**] [**Type MH, moderate heat of hydration**] [**Type LH, low heat of hydration**].
- H. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 3S**] [**Class 3M**] [**Class 1N**] <Insert class> coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than **4 lb./cu. yd.** for moderately reactive aggregate or **3 lb./cu. yd.** for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with **ACI 301**.
 2. Maximum Coarse-Aggregate Size: **[1-1/2 inches] [1 inch] [3/4 inch]** <Insert dimension> nominal.
 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- I. Lightweight Aggregate: ASTM C330/C330M, **[1-inch] [3/4-inch] [1/2-inch] [3/8-inch]** nominal maximum aggregate size.
- J. Water and Water Used to Make Ice: ASTM C94/C94M, potable [or] **[complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4]**

2.3 ~~AD MIXTURES~~

- A. ~~Air-Entraining Admixture: ASTM C260/C260M.~~
- B. ~~Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride [in steel-reinforced concrete].~~
1. ~~Water-Reducing Admixture: ASTM C494/C494M, Type A.~~
 2. ~~Retarding Admixture: ASTM C494/C494M, Type B.~~
 3. ~~Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.~~
 4. ~~High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.~~
 5. ~~High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.~~
 6. ~~Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.~~

2.4 ~~FLOOR AND SLAB TREATMENTS~~

- A. ~~Emery Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.~~
1. ~~Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].~~
- B. ~~Metallic Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.~~
1. ~~Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].~~

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd.** when dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below **50 deg F**: Black.

b. Ambient Temperature between **50 deg F** and **85 deg F**: Any color.

c. Ambient Temperature Above **85 deg F**: White.

C. Water: Potable or complying with ASTM C1602/C1602M.

2.6 RELATED MATERIALS

A. Expansion and Isolation Joint Filler Strips: ~~[ASTM D1751, asphalt-saturated cellulosic fiber] [or] [ASTM D1752, cork or self-expanding cork].~~

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, ~~[epoxy resin with a Type A shore durometer hardness of 80] [aromatic polyurea with a Type A shore durometer hardness range of 90 to 95]~~ in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. ~~[Types I and II, nonload bearing] [Types IV and V, load bearing]~~, for bonding hardened or freshly mixed concrete to hardened concrete.

2.72.3 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/8 inch** and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch** or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than **[4100 psi]** <Insert strength> at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from **1/4 inch** and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, **1/8 to 1/4 inch** or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than **[5000 psi]** <Insert strength> at 28 days when tested in accordance with ASTM

C109/C109M.

2.82.4 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, in accordance with **ACI 301**.
1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
 2. Slag Cement: 50 percent by mass.
 3. Silica Fume: 10 percent by mass.
 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use [water-reducing] [high-range water-reducing] [or] [plasticizing] admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in [pumped concrete,] [concrete for heavy-use industrial slabs] [concrete for parking structure slabs,] [and] [concrete with a w/cm below 0.50].
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 5. Use permeability-reducing admixture in concrete mixtures where indicated.
- D. Color: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.92.5 CONCRETE MIXTURES

- A. Class [A] <Insert designation>: Normal-weight concrete used for footings, grade beams, and tie beams.
1. Exposure Class: **ACI 318** [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] <Insert strength> at 28 days.
 3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
 4. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
 5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 6. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch

- nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
- b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- B. Class [B] <Insert designation>: Normal-weight concrete used for foundation walls.
1. Exposure Class: ACI 318 [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] <Insert strength> at 28 days.
 3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
 4. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
 5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 6. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- C. Class [C] <Insert designation>: Normal-weight concrete used for interior slabs-on-ground.
1. Exposure Class: ACI 318 [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] <Insert strength> at 28 days.
 3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
 4. Minimum Cementitious Materials Content: [470 lb/cu. yd.] [520 lb/cu. yd.] [540 lb/cu. yd.] [610 lb/cu. yd.].
 5. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
 6. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 7. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-

finished floors.

8. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
9. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] <Insert weight>.
10. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] <Insert dosage>.
11. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] <Insert dosage>.

D. Class [D] <Insert designation>: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: ACI 318 [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert strength> [As indicated] at 28 days.
3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
4. Minimum Cementitious Materials Content: [470 lb/cu. yd.] [520 lb/cu. yd.] [540 lb/cu. yd.] [610 lb/cu. yd.].
5. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
6. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
7. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
8. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
9. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] <Insert weight>.
10. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] <Insert dosage>.
11. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] <Insert dosage>.

E. Class [E] <Insert designation>: Structural lightweight concrete used for interior suspended slabs.

1. Exposure Class: ACI 318 [F0] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert strength> [As indicated] at 28 days.
3. Calculated Equilibrium Unit Weight: [115 lb/cu. ft.] [110 lb/cu. ft.] [105 lb/cu. ft.], plus or minus 3 lb/cu. ft. as determined by ASTM C567/C567M.
4. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
6. Air Content:

- a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
 8. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] <Insert weight>.
 9. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] <Insert dosage>.
 10. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] <Insert dosage>.
- F. Class [F] <Insert designation>: Normal-weight concrete used for concrete toppings.
1. Exposure Class: ACI 318 [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert strength> [As indicated] at 28 days.
 3. Minimum Cementitious Materials Content: [470 lb/cu. yd.] [520 lb/cu. yd.] [540 lb/cu. yd.]
 4. Slump Limit: [4 inches] [5 inches], plus or minus 1 inch.
 5. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 6. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished toppings.
 7. Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] <Insert weight>.
 8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] <Insert dosage>.
 9. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] <Insert dosage>.
- G. Class [G] <Insert designation>: Normal-weight concrete used for building frame members.
1. Exposure Class: ACI 318 [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert strength> [As indicated] at 28 days.
 3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.

4. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
 5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 6. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- H. Class [H] <Insert designation>: Normal-weight concrete used for building walls.
1. Exposure Class: ACI 318 [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert strength> [As indicated] at 28 days.
 3. Maximum w/cm: [0.50] [0.45] [0.40] <Insert number>.
 4. Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches, plus or minus 1 inch, before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert limits>.
 5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 6. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.
- I. Class [I] <Insert designation>: Normal-weight concrete used for interior metal pan stairs and landings:
1. Exposure Class: ACI 318 [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [3000 psi] <Insert strength> [As indicated] at 28 days.
 3. Maximum w/cm: [0.53] [0.45] [0.40] <Insert number>.
 4. Minimum Cementitious Materials Content: 470 lb/cu. yd..
 5. Maximum Size Aggregate: 1/2 inch.

6. Slump Limit: **3 inches**, plus **1 inch** or minus **2 inches**.
 7. Air Content: **[0]** **<Insert number>** percent, plus or minus 0.5 percent at point of delivery.
 8. Limit water-soluble, chloride-ion content in hardened concrete to **[1.00]** **[0.30]** **[0.15]** **<Insert number>** percent by weight of cement.
 9. Retarding Admixture: Not allowed.
 10. Accelerating Admixture: Not allowed.
- J. Class **[J]** **<Insert designation>**: Normal-weight concrete used for exterior retaining walls.
1. Exposure Class: **ACI 318** **[F0]** **[F1]** **[F2]** **[F3]** **[S0]** **[S1]** **[S2]** **[S3]** **[W0]** **[W1]** **[C0]** **[C1]** **[C2]**.
 2. Minimum Compressive Strength: **[5000 psi]** **[4500 psi]** **[4000 psi]** **[3500 psi]** **[3000 psi]** **<Insert strength>** **[As indicated]** at 28 days.
 3. Maximum w/cm: **[0.50]** **[0.45]** **[0.40]** **<Insert number>**.
 4. Slump Limit: **[4 inches, plus or minus 1 inch]** **[5 inches, plus or minus 1 inch]** **[8 inches, plus or minus 1 inch]** for concrete with verified slump of **3 inches, plus or minus 1 inch**, before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<Insert limits>**.
 5. Slump Flow Limit: **[22 inches, plus or minus 1.5 inches]** **[30 inches, plus or minus 2.5 inches]** **<Insert limits>**.
 6. Air Content:
 - a. Exposure Class F1: **[5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size]** **[4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size]** **[4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size]**.
 - b. Exposure Classes F2 and F3: **[6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size]** **[6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size]** **[5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size]**.
 7. Limit water-soluble, chloride-ion content in hardened concrete to **[1.00]** **[0.30]** **[0.15]** **<Insert number>** percent by weight of cement.

2.102.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M[and ASTM C1116/C1116M], and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 1. For mixer capacity of **1 cu. yd.** 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.
 2. For mixer capacity larger than **1 cu. yd.**, increase mixing time by 15 seconds for each additional **1 cu. yd.**.
 3. 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 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 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 ANSI/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.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than **6 inches**, sealing vapor retarder to concrete.
4. Lap joints **6 inches** and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

- a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by **6 inches** on all sides, and sealing to vapor retarder.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 3. Form keyed joints as indicated. Embed keys at least **1-1/2 inches** into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points of spans. 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 [**as indicated on Drawings**] **<Insert spacing>**. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least [**one-fourth**] **<Insert depth>** of concrete thickness as follows:
 1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of **1/8 inch**. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
 2. Terminate full-width joint-filler strips not less than **1/2 inch** or more than **1 inch** below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of **ACI 301**, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. 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.
1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with **ACI 301**.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches** into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. **ACI 301** Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than **1-1/2 inches** wide or **1/2 inch** deep.
 - b. Remove projections larger than **1 inch**.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: **ACI 117** Class D.
 - e. Apply to concrete surfaces [**not exposed to public view**] <Insert locations>.
2. **ACI 301** Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than **3/4 inch** wide or **1/2 inch** deep.
 - b. Remove projections larger than **1/4 inch**.
 - c. Patch tie holes.
 - d. Surface Tolerance: **ACI 117** Class B.
 - e. Locations: 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**] <Insert locations>.
3. **ACI 301** Surface Finish SF-3.0:
 - a. Patch voids larger than **3/4 inch** wide or **1/2 inch** deep.
 - b. Remove projections larger than **1/8 inch**.
 - c. Patch tie holes.
 - d. Surface Tolerance: **ACI 117** Class A.
 - e. Locations: 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**] <Insert locations>.

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:
 - a. Perform no later than one day after form removal.
 - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
 - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.

- d. Maintain required patterns or variances as shown on Drawings or to match [design reference sample] [field sample panels] [mockups].
2. Grout-Cleaned Rubbed Finish:
 - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
 - b. Do not clean concrete surfaces as Work progresses.
 - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - d. Wet concrete surfaces.
 - e. 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.
 - f. Maintain required patterns or variances as shown on Drawings or to match [design reference sample] [field sample panels] [mockups].
3. Cork-Floated Finish:
 - a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
 - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - c. Wet concrete surfaces.
 - d. Compress grout into voids by grinding surface.
 - e. In a swirling motion, finish surface with a cork float.
 - f. Maintain required patterns or variances as shown on Drawings or to match [design reference sample] [field sample panels] [mockups].
4. Scrubbed Finish: After concrete has achieved a compressive strength of from **1000 to 1500 psi**, apply scrubbed finish.
 - a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
 - b. Rinse scrubbed surfaces with clean water.
 - c. Maintain continuity of finish on each surface or area of Work.
 - d. Remove only enough concrete mortar from surfaces to match [design reference sample] [field sample panels] [mockups].
- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
 1. Perform abrasive blasting after compressive strength of concrete exceeds **2000 psi**.
 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
 3. Surface Continuity:
 - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
 - b. Maintain required patterns or variances in depths of blast to match [design reference sample] [field sample panels] [mockups].
 4. Abrasive Blasting:

- a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
 - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
 - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
 - 1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
 - 2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of **1/16 inch**.
 - 3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of **1/4 inch**.
 - 4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of **1/4 to 1/2 inch**.
 - d. Maintain required patterns or variances in reveal projection to match **[design reference sample] [field sample panels] [mockups]**.
- D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of **4500 psi**.
 2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
 3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
 4. Maintain required patterns or variances in reveal projection to match **[design reference sample] [field sample panels] [mockups]**.
- E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of **4500 psi**.
 2. Surface Continuity:
 - a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
 3. Surface Cut:
 - a. Maintain required depth of cut and general aggregate exposure.
 - b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
 4. Remove impressions of formwork and form facings with exception of tie holes.
 5. Maintain required patterns or variances of cut as shown on Drawings or to match **[design reference sample] [field sample panels] [mockups]**.
 6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, wind-breaks, or similar devices.
- F. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish:
 1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
 2. Use stiff brushes, brooms, or rakes to produce a profile depth of **1/4 inch** in one direction.
 3. Apply scratch finish to surfaces [to receive concrete floor toppings] [to receive mortar setting beds for bonded cementitious floor finishes] <Insert locations>.
- C. Float Finish:
 1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
 2. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture and complies with **ACI 117** tolerances for conventional concrete.
 3. Apply float finish to surfaces [to receive trowel finish] [and] [to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo] <Insert locations>.
- D. Trowel Finish:
 1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
 2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
 3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 4. Do not add water to concrete surface.
 5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
 6. 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] <Insert locations>.
 7. Finish surfaces to the following tolerances, in accordance with **ASTM E1155**, for a randomly trafficked floor surface:
 - a. Slabs on Ground:
 - 1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, **10-ft.-** long straightedge resting on two high spots and placed anywhere on the surface does not exceed **[1/4 inch] [3/16 inch] [1/8 inch] [1/8 inch and also no more than 1/16 inch in 2 feet]**.
 - 2) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.
 - 3) Specified overall values of flatness, FF 35; and of levelness, FL 25; with minimum local values of flatness, FF 24; and of levelness, FL 17.
 - 4) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

- 5) Specified overall values of flatness, FF 50; and of levelness, FL 25; with minimum local values of flatness, FF 40; and of levelness, FL 17.
- b. Suspended Slabs:
 - 1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, **10-ft.-** long straightedge resting on two high spots and placed anywhere on the surface does not exceed **[1/4 inch] [3/16 inch] [1/8 inch] [1/8 inch and also no more than 1/16 inch in 2 feet]**.
 - 2) Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.
 - 3) Specified overall values of flatness, FF 35; and of levelness, FL 20; with minimum local values of flatness, FF 24; and of levelness, FL 15.
 - 4) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces **[indicated on Drawings]** **[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 perpendicular to main traffic route.
 1. Coordinate required final finish with Architect before application.
 2. 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 locations indicated on Drawings.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
 2. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive **[aggregate]** **[aluminum granule]** finish to concrete stair treads, platforms, ramps as indicated on Drawings
 1. Apply in accordance with manufacturer's written instructions and as follows:
 - a. Uniformly spread **[25 lb/100 sq. ft.]** **<Insert rate>** of dampened slip-resistive **[aggregate]** **[aluminum granules]** over surface in one or two applications.
 - b. Tamp aggregate flush with surface, but do not force below surface.
 - c. After broadcasting and tamping, apply float finish.
 - d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive **[aggregate]** **[aluminum granules]**.
- H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:
 1. Uniformly apply dry-shake floor hardener at a rate of **[100 lb/100 sq. ft.]** **<Insert rate>** unless greater amount is recommended by manufacturer.
 2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
 3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.

4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

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

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases [4 inches] [6 inches] [8 inches] <Insert dimension> high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] <Insert value> at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.

2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
 3. If forms remain during curing period, moist cure after loosening forms.
 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheetting Materials: Cover exposed concrete surfaces with sheetting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.
- C. Curing Unformed Surfaces: Comply with **ACI 308.1** as follows:
1. Begin curing immediately after finishing concrete.
 2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than **12 inches**.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but 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**, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
 - b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than **12 inches**.

- b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but 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**, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than **12 inches**.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
 - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
 - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
 - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
 - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Urethane Flooring:
 - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped **6 inches** and sealed in place.
 - 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
 - 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:

- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[**unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project**].

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

- A. Conform to **ACI 117**.

~~3.12 APPLICATION OF LIQUID FLOOR TREATMENTS~~

- ~~A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.~~

- ~~1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.~~
- ~~2. Do not apply to concrete that is less than **[three]** **[seven]** **[14]** **[28]** days' old.~~
- ~~3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.~~
- ~~4. Rinse with water; remove excess material until surface is dry.~~
- ~~5. Apply a second coat in a similar manner if surface is rough or porous.~~

- ~~B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.~~

~~3.13~~3.12 JOINT FILLING

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

- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.143.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a **No. 16** sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than **1/2 inch** in any dimension to solid concrete.
 - a. Limit cut depth to **3/4 inch**.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of **0.01 inch** wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of **1/4 inch** to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes **1 inch** or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a **3/4-inch** clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes **1 inch** or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.153.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
 1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

- a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results.
 - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
 1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding **5 cu. yd.**, but less than **25 cu. yd.**, plus one set for each additional **50 cu. yd.** or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. 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.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Slump Flow: ASTM C1611/C1611M:

- a. 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.
 - b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; **[ASTM C173/C173M volumetric method, for structural lightweight concrete]**.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is **40 deg F** and below or **80 deg F** and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of **[two]** **[three]** **[four]** **6-inch** by **12-inch** or **4-inch** by **8-inch** cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure **[two]** **<Insert number>** sets of **[two]** **[three]** **[four]** standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of **[two]** **[three]** **[four]** laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. Test one set of **[two]** **[three]** **[four]** field-cured specimens at seven days and one set of two specimens at 28 days.
 - c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than **500 psi** if specified compressive strength is **5000 psi**, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than **5000 psi**.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
 - a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength to be in accordance with **ACI 301**, Section 1.6.6.3.

13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with **ASTM E1155** within [24] [48] [72] <Insert number> hours of completion of floor finishing and promptly report test results to Architect.

3.163.15 PROTECTION

- A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
 2. Diaper hydraulic equipment used over concrete surfaces.
 3. Prohibit vehicles from interior concrete slabs.
 4. Prohibit use of pipe-cutting machinery over concrete surfaces.
 5. Prohibit placement of steel items on concrete surfaces.
 6. Prohibit use of acids or acidic detergents over concrete surfaces.
 7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
 8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 033300 - 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 033000 "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. Design Reference Sample: Sample 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]** <Insert location>.
 - 1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Cast-in-place architectural concrete Subcontractor.
 - 2. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction joints, control joints, isolation joints, and joint-filler strips.
 - c. Reinforcement accessory installation.
 - d. Cold- and hot-weather concreting procedures.

- e. Concrete finishes and finishing.
- f. Curing procedures.
- g. Forms and form-removal limitations.
- h. Shoring and reshoring procedures.
- i. Concrete repair procedures.
- j. Protection of cast-in-place architectural concrete.
- k. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
- l. Protection of field-cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

- 1. Form-facing panels.
- 2. Form liners.
- 3. Form joint tape.
- 4. Form joint sealant.
- 5. Wood sealer.
- 6. Form-release agent.
- 7. Surface retarder.
- 8. Form ties.
- 9. Bar supports.
- 10. Portland cement.
- 11. Fly ash.
- 12. Slag cement.
- 13. Blended hydraulic cement.
- 14. Silica fume.
- 15. Performance-based hydraulic cement.
- 16. Aggregates.
- 17. 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.

- 18. Color pigments.
- 19. Repair materials.

B. Sustainable Design Submittals:

- 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- 2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
- 3. Environmental Product Declaration (EPD): For each product.
- 4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
- 5. Environmental Product Declaration: For each product.
- 6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or

- recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
 8. Environmental Product Declaration: For each product.
 9. Third-Party Certifications: For each product.
 10. Third-Party Certified Life Cycle Assessment: For each product.
 11. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:
 - a. Inventory or HPD to at least 0.01 percent by weight with no GreenScreen LT-1 or GHS Category 1 hazards.
 - b. Inventory or HPD to at least 0.01 percent by weight, with at least 75 percent assessed using GreenScreen Benchmark assessment.
 - c. Third-party-verified Declare product label, designated "Red List Free."
 - d. Material Health Certificate or Cradle to Cradle certification with minimum Bronze level of Material Health.
- C. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Durability exposure class.
 4. Maximum w/cm.
 5. Calculated equilibrium unit weight, for lightweight concrete.
 6. Slump limit.
 7. Air content.
 8. Nominal maximum aggregate size.
 9. Steel-fiber reinforcement content.
 10. Synthetic microfiber content.
 11. Amounts of mixing water to be withheld for later addition at Project site if permitted.
 12. Intended placement method.
 13. Alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Shop Drawings:
1. Formwork: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - a. Show formwork construction, including form-liner layout, form-liner termination details, dimensioned locations of form-facing material joints, rustications, construction and contraction joints, form joint-sealant details, form-tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
 - 1) Included separate layout for formwork used in [field sample panels] [and] [mockups].
 - 2) Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
 - 3) Location of construction joints is subject to approval of Architect.
- E. Samples: For each of the following materials:
1. Form-facing panels.
 2. Form ties.

3. Form liners, **12-by-12-inch** Sample, indicating texture.
 4. Manufacturer's standard colors for color pigment.
 5. Exposed aggregates.
 6. Chamfers and rustications.
- F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately **18 by 18 by 2 inches**, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.
- G. 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.
- H. Placement Schedule: Submit before start of placement operations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
1. Installer: Include copies of applicable ACI certificates.
 2. Ready-mixed concrete manufacturer.
- B. Material Certificates: For each of the following:
1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Repair materials.
- C. Material Test Reports: For the following, by a qualified testing agency:
1. Portland cement.
 2. Fly ash.
 3. Slag cement.
 4. Blended hydraulic cement.
 5. Silica fume.
 6. Performance-based hydraulic cement.
 7. Aggregates[: **Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity**].
- D. Research Reports: For concrete admixtures in accordance with ICC AC198.
- E. Preconstruction Test Reports: For each mix design.
- F. Concrete Repair: Submit a written, detailed description of materials, methods, equipment, and sequence of operations to be used for repairing architectural concrete, including protection of surrounding materials and Project site.

1. If materials and methods other than those indicated are proposed for any repairs to architectural concrete, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and Installer's ability to use such materials and methods properly.
- G. Minutes of preinstallation conference.

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. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Technical Manager.
 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level I.
 2. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Level II.
- D. 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** 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.
- E. 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.
 - f. Permeability.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and **ACI 301**.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."
- B. Hot-Weather Placement: Comply with Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

~~2.2 FORM-FACING MATERIALS~~

- ~~A. Comply with Section 031000 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.~~

- B.—— Source Limitations: Obtain each type of form-facing material from single source from single manufacturer.
- C.—— Form-Facing Panels for ~~[As-Cast]~~ ~~[Exposed-Aggregate]~~ 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, ~~[high-density overlay, Class 1, or better]~~ ~~[medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed]~~, complying with DOC PS 1 ~~[, or Finnish phenolic overlaid birch plywood]~~.
- D.—— Form Liners: Units of face design, texture, arrangement, and configuration ~~[indicated]~~ ~~[to match design reference sample]~~. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments and finishes of concrete.
- E.—— Rustication Strips: Metal ~~[, dressed wood,]~~ or rigid plastic, with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
- F.—— Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, **3/4 by 3/4 inch**, minimum; nonstaining; in longest practicable lengths.
- G.—— Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum **1/4 inch** thick.
- H.—— 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.
- I.—— 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.
- J.—— 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.
 - 2.—— Form-release agent for form liners to be acceptable to form-liner manufacturer.
- K.—— Form Ties: Factory-fabricated, ~~[glass-fiber-reinforced plastic]~~ ~~[internally disconnecting]~~ ~~[or]~~ ~~[removable]~~ ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
- 1.—— Furnish ties ~~[with tapered tie cone spreaders]~~ that, when removed, will leave holes no larger than ~~[3/4 inch]~~ ~~[1 inch]~~ ~~[1-1/4 inches]~~ ~~[1-1/2 inches]~~ **<Insert dimension>** in diameter on architectural concrete surface.
 - 2.—— Furnish internally disconnecting ties that will leave no metal closer than **1-1/2 inches** ~~[, after exposing aggregate,]~~ from architectural concrete surface.
 - 3.—— Furnish glass-fiber-reinforced plastic ties, not less than **1/2 inch** and not more than **1 inch** in diameter, of color ~~[to match Architect's sample]~~ ~~[selected by Architect from manufacturer's full range]~~.
 - 4.—— Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.32.2 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. Where legs of wire bar supports contact forms, use [gray, all-plastic] [CRSI Class 1, gray, plastic-protected] [or] [CRSI Class 2, stainless steel] bar supports.

2.4 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates ~~and cementitious materials~~ that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- B. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site.
- C. Regional Materials: Concrete shall be manufactured within **100 miles** of Project site from aggregates ~~and cementitious materials~~ that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- D. Indigenous Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates ~~and cementitious materials~~ that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- E. Regional Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates ~~and cementitious materials~~ that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, [Type I] [Type II] [Type I/II] [Type III], [gray] [white].
 2. Fly Ash: [ASTM C618, Class C] [ASTM C618, Class F] [ASTM C618, Class C or Class F] [Not allowed].
 3. Slag Cement: [ASTM C989/C989M, Grade 100 or Grade 120] [Not allowed].
 4. Blended Hydraulic Cement: ASTM C595/C595M, [Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type II, portland-limestone] [Type IT, ternary blended] cement.
 5. Silica Fume: [ASTM C1240 amorphous silica] [Not allowed].
 6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [Type GU, general use] [Type HE, high early strength] [Type MS, moderate sulfate resistance] [Type HS, high sulfate resistance] [Type MH, moderate heat of hydration] [Type LH, low heat of hydration].
- G. Normal-Weight Aggregates: ASTM C33/C33M, [Class 5S] [Class 5M] [Class 1N] <Insert class> coarse aggregate or better, graded. Provide aggregates from single source from single manufacturer.
1. Alkali-Silica Reaction: Comply with one of the following:
- a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at 14 days

when tested in accordance with ASTM C1567.

- c. ~~Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.~~

2. ~~Maximum Coarse Aggregate Size: [1 inch] [3/4 inch] [1/2 inch] [3/8 inch].~~

3. ~~Gradation: [Uniformly] [Gap] graded.~~

H. ~~Normal-Weight Fine Aggregate: [ASTM C33/C33M] [or] [ASTM C144], manufactured or natural sand, free of materials with deleterious reactivity to alkali in cement, from same source for entire Project.~~

I. ~~Air-Entraining Admixture: As specified in Section 033000 "Cast-in-Place Concrete."~~

J. ~~Chemical Admixtures: As specified in Section 033000 "Cast-in-Place Concrete," and 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.~~

K. ~~Water and Water Used to Make Ice: ASTM C94/C94M, potable [or] [complying with ASTM C1602/C1602M, including all limits listed in Table 2 and requirements of paragraph 5.4].~~

2.52.3 CURING MATERIALS

A. Comply with Section 0330000 "Cast-in-Place Concrete."

1. For integrally colored concrete, curing materials to be approved by color pigment manufacturer.
2. For concrete indicated to be sealed, curing materials to be compatible with sealer.

2.62.4 REPAIR MATERIALS

A. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C881/C881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements.

1. **[Types I and II, non-load bearing] [Types IV and V, load bearing]**, for bonding hardened or freshly mixed concrete to hardened concrete.

2.72.5 CONCRETE MIXTURES, GENERAL

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, in accordance with **ACI 301**.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs, based on laboratory trial mixtures.

- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
 2. Slag Cement: 50 percent by mass.
 3. Silica Fume: 10 percent by mass.
 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- D. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
- E. Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved [design reference sample] [field sample panels] [mockups].

2.82.6 CONCRETE MIXTURES

- A. Class [K] <Insert designation>: Normal-weight concrete.
1. Exposure Class: **ACI 318** [F0] [F1] [F2] [F3] [S0] [S1] [S2] [S3] [W0] [W1] [C0] [C1] [C2].
 2. Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] <Insert strength> at 28 days.
 3. Maximum w/cm: 0.46.
 4. Slump Limit: [3 inches, plus or minus 1 inch] [4 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site] <Insert dimension(s)>.
 5. Slump Flow Limit: [22 inches, plus or minus 1.5 inches] [30 inches, plus or minus 2.5 inches] <Insert limits>.
 6. Air Content:
 - a. Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 - b. Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size].
 7. Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] <Insert number> percent by weight of cement.

2.92.7 CONCRETE MIXING

- A. [Ready-Mixed] [or] [Project-Site-Mixed] Architectural Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M [and ASTM C1116/C1116M], 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. 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.**, increase mixing time by 15 seconds for each additional **1 cu. yd.**.
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 031000 "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** requirements.
- C. Limit cast-in-place architectural concrete surface irregularities, as follows:
 1. Surface Finish-1.0: **ACI 117** Class D, **1 inch**.
 2. Surface Finish-2.0: **ACI 117** Class B, **1/4 inch**.
 3. Surface Finish-3.0: **ACI 117** Class A, **1/8 inch**.
- D. Construct forms to result in cast-in-place architectural concrete that complies with **ACI 117**.
 1. Also comply with the following tolerances: **<Insert tolerances>**.
- E. Seal form joints, chamfers, rustication joints, and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
 1. Provide closure backing materials if indented rustication is used over a ribbed form line, and seal joint between rustication strip and form with joint sealant.
- F. **[Chamfer]** **[Do not chamfer]** exterior corners and edges of cast-in-place architectural concrete.
- G. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.
- H. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.
- I. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.
- J. Place form liners accurately to provide finished surface texture indicated.
 1. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.
 2. Secure form liners in place using fasteners that will not transfer impressions onto surface of concrete.
 3. Prevent form liners from sagging and stretching in hot weather.
 4. Seal joints of form liners and form-liner accessories to prevent mortar leaks.
 5. Coat form liner with form-release agent.

3.2 INSTALLATION OF REINFORCEMENT AND ACCESSORIES

- A. Comply with Section 032000 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.

3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F** for [24] <Insert number> hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
 - 1. Schedule form removal to maintain surface appearance that matches approved [design reference sample] [field sample panels] [mockups].
 - 2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved [at least 70 percent of] its 28-day design compressive strength.
 - 3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 - 4. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. Clean and repair surfaces of forms to be reused in the Work.
 - 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 - 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
 - 1. Align and secure joints to avoid offsets.
 - 2. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 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.
 - 2. Form keyed joints as indicated. [Embed keys at least **1-1/2 inches** into concrete.] Align construction joint within rustications attached to form-facing material.
 - 3. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at top of footings or floor slabs.
 - 5. Space vertical joints in walls [as indicated on Drawings] <Insert spacing>. Unless otherwise indicated on Drawings, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use [bonding agent] [epoxy-bonding adhesive] at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- B. Contraction Joints: Form weakened-plane contraction 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 on Drawings or as approved by Architect.

3.5 CONCRETE PLACEMENT

- A. Comply with Section 033000 "Cast-in-Place Concrete."

3.6 FINISHING FORMED SURFACES

- A. Comply with Section 033000 "Cast-in-Place Concrete."
- B. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- C. As-Cast Surface Finishes: Comply with Section 033000 "Cast-in-Place Concrete" for the following:
 - 1. **ACI 301** Surface Finish-1.0 (SF-1.0).
 - 2. **ACI 301** Surface Finish-2.0 (SF-2.0).
 - 3. **ACI 301** Surface Finish-3.0 (SF-3.0).
- D. Final Concrete Finish: Comply with Section 033000 "Cast-in-Place Concrete" for the following:
 - 1. Smooth-rubbed finish.
 - 2. Grout-cleaned rubbed finish.
 - 3. Cork-floated finish.
 - 4. Abrasive-blast finish.
 - 5. Scrubbed finish.
 - 6. High-pressure water-jet finish.
 - 7. Bushhammer finish.
- E. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.
- F. Maintain uniformity of architectural concrete finishes over construction joints unless otherwise indicated.

3.7 CONCRETE CURING

- A. Comply with Section 033000 "Cast-in-Place Concrete" using identical curing procedures to that used for [field sample panels] [mockups].

3.8 REPAIR

- A. Comply with **ACI 301**.
- 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 [field sample panels] [mockups].
- D. Remove and replace cast-in-place architectural concrete that cannot be repaired to Architect's approval.

3.9 FIELD QUALITY CONTROL

- A. Comply with Section 033000 "Cast-in-Place Concrete."

3.10 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.

3.11 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.

3.12 FINAL ACCEPTANCE

- A. Final acceptance of completed architectural concrete Work will be determined by Architect by comparing approved [design reference sample] [field sample panels] [mockups] with installed Work, when viewed at a distance of [20 feet] <Insert distance>.

END OF SECTION 033300

SECTION 033543 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polished concrete finishing[, **including staining**] [**and scoring**].
2. Concrete for polished concrete, including concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 033000 "Cast-in-Place Concrete."

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete not designated as polished concrete.

1.2 DEFINITIONS

- A. Design Reference Sample:** Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with polished concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Cast-in-place concrete subcontractor.
 - e. Polished concrete finishing Subcontractor.
2. Review [~~cold- and hot-weather concreting procedures,~~] [**curing procedures,**] [**construction joints,**] [**concrete repair procedures,**] [**concrete finishing,**] and protection of polished concrete.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Laboratory Test Reports: For [~~stains~~] [**and**] [**liquid floor treatments**], indicating compliance with requirements for low-emitting

materials.

- C. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.
- D. Samples for Initial Selection: For each type of product requiring color selection.
- E. Samples for Verification: For each type of exposed color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Repair materials.
 - 2. Stain materials.
 - 3. Liquid floor treatments.

1.6 QUALITY ASSURANCE

- A. Field Sample Panels: After approval of verification sample and before casting 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, approximately **48 by 48 inches** minimum, to demonstrate the expected range of finish, color, and appearance variations.
 - 1. Locate panels as indicated or, if not indicated, as directed by Architect.
 - 2. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Demolish and remove field sample panels when directed.
- B. Mockups: Before casting concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, 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. Demonstrate curing, finishing, and protecting of polished concrete.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS
PART 3 - EXECUTION

3.1 POLISHING

- A. Polish: [Level 1: Matte finish, 100 grit] [Level 2: Low sheen, 400 grit] [Level 3: High sheen, 800 grit] [Level 4: Gloss shine, 3000 grit] [Match design reference sample].
- B. Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
 - 1. Machine grind floor surfaces to receive polished finishes level and smooth[**and to depth required to reveal aggregate to match approved mockup**].
 - 2. Apply reactive stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
 - 3. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
 - 4. Apply penetrating stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
 - 5. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
 - 6. Control and dispose of waste products produced by grinding and polishing operations.
 - 7. Neutralize and clean polished floor surfaces.

3.2 STAINING

- A. Newly placed concrete to be at least [14] [30] <Insert number> days old before staining.
- B. Prepare surfaces according to manufacturer's written instructions and as follows:
 - 1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.
 - a. Do not use acidic solutions to clean surfaces.
 - 2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by [acid etching] [grinding, sanding, or abrasive blasting]. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
 - 3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
 - 4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F710 to ensure pH is between [7 and 8] <Insert values>.
- C. Scoring: Score decorative jointing in concrete surfaces **1/16 inch** deep with diamond blades to match pattern indicated. Rinse until water is clear. Score [after] [before] staining.
 - 1. Joint Width: [**3/8 inch**] <Insert dimension>.
- D. Allow concrete surface to dry before applying stain. Verify readiness of concrete to receive stain according to ASTM D4263 by tightly taping **18-by-18-inch, 4-mil-** thick polyethylene sheet to a representative area of concrete surface. Apply stain only if no evidence of

moisture has accumulated under sheet after 16 hours.

- E. Reactive Stain: Apply reactive stain to concrete surfaces according to manufacturer's written instructions and as follows:
1. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
 2. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.
- F. Penetrating Stain: Apply penetrating stain to concrete surfaces according to manufacturer's written instructions and as follows:
1. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
 2. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
 3. Rinse until water is clear. Control, collect, and legally dispose of runoff.

END OF SECTION 033543

SECTION 035300 - CONCRETE TOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Emery-aggregate concrete floor topping.~~
- ~~2. Iron-aggregate concrete floor topping.~~

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each concrete floor topping, for tests performed by **[manufacturer and witnessed by a qualified testing agency]** **[a qualified testing agency]**.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C1077 and ASTM E329 for testing indicated.
- B. Mockups: Place concrete floor topping mockups to demonstrate typical joints, surface finish, bonding, texture, tolerances, and standard of workmanship.
1. Build mockups approximately **100 sq. ft.** in the location indicated or, if not indicated, as directed by Architect.
 2. If Architect determines that mockups do not meet requirements, demolish and remove them from the site and cast others until mockups are approved.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.
 - 1. Place concrete floor topping only when ambient temperature and temperature of base slabs are between **50 and 86 deg F**.
- B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 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 C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 25 percent solids content, minimum.

2.2 RELATED MATERIALS

- A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids [**epoxy resin with a Type A Shore durometer hardness of 80**] [**aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95**] according to ASTM D2240.
- B. Joint-Filler Strips: [**ASTM D1751, asphalt-saturated cellulosic fiber**] [or] [**ASTM D1752, cork or self-expanding cork**].
- C. Portland Cement: ASTM C150/C150M, Type I or II.
- D. Sand: ASTM C404, fine aggregate passing **No. 16** sieve.
- E. Water: Potable.
- F. Acrylic-Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- G. Epoxy Adhesive: ASTM C881/C881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.
- H. Power-Actuated Fasteners: Fastener systems with an evaluation report based on ICC-ES AC70.

2.3 MIXING

- A. Bonding Slurry:
 - 1. Mix portland cement with water to a thick paint consistency.
 - 2. Mix 1 part portland cement and [1-1/2] [2] [2-1/2] parts sand with water[**and an acrylic-bonding agent according to manufacturer's written instructions**] to a thick paint consistency.
- B. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for conditions affecting performance of the Work.
- B. Verify that base concrete slabs comply with scratch finish requirements specified in Section 033000 "Cast-in-Place Concrete."
- C. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method according to ASTM D4263.
- D. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of **1/4 inch**.
 - 1. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
 - 2. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.
 - 3. Saw cut contraction and construction joints in existing concrete to a depth of **1/2 inch** and fill with semirigid joint filler.
 - 4. To both sides of joint edges and at perimeter of existing base slab, [**mechanically remove a 4-inch-wide and 0- to 1-inch-deep, tapered wedge of concrete and retexture surface**] [**install concrete nails in manufacturer's recommended staggered pattern**].
- B. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface unless otherwise indicated.
 - 2. Terminate full-width, joint-filler strips **1/2 inch** below topping surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- C. Install power-actuated fasteners according to written directions of floor topping manufacturer at perimeter of areas that are to receive floor topping, including both edges of locations where joints will be formed in floor topping.

3.3 FLOOR TOPPING APPLICATION

- A. Start floor topping application in presence of manufacturer's technical representative.
- B. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Section 033000 "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.
- C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of **1/16 to 1/8 inch**, without puddling. Place floor topping while slurry is still tacky.
- D. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of **1/16 to 1/8 inch**, without puddling. Place floor topping while adhesive is still tacky.
- E. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
 - 1. Screed surface with a straightedge and strike off to correct elevations.
 - 2. Slope surfaces uniformly where indicated.
 - 3. Begin initial floating, using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
- F. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.
 - 1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
 - a. Finish surfaces to specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15, and [measure] **[notify independent testing agency to permit measurement]** within 24 hours according to **ASTM E1155** for a randomly trafficked floor surface.
 - b. Finish and measure surface, so gap at any point between surface and an unlevelled freestanding **10-foot-** long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed **1/4 inch**.
- G. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by Architect.
 - 1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.
- H. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch-** wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.
 - 1. Form joints in concrete floor topping over contraction joints in base slabs unless otherwise indicated.
 - 2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
 - 3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than **1/2 inch** deep.

3.4 PROTECTING AND CURING

- A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.
- B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.
- C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with [water] [continuous water-fog spray] [or] [absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch lap over adjacent absorptive covers].
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in two coats in continuous operations 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.

3.5 JOINT FILLING

- A. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.6 REPAIR

- A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing and inspecting of completed applications of concrete floor toppings to take place in successive stages, in areas of extent and using methods as follows:
 - 1. Sample Sets: At point of placement, a set of three molded-cube samples to be taken from the topping mix for the first 1000 sq. ft., plus one set of samples for each subsequent 5000 sq. ft. of topping, or fraction thereof, but not less than six samples for each day's placement. Samples to be tested according to ASTM C109/C109M for compliance with compressive-strength

- requirements.
 - 2. Concrete floor topping to be tested for delamination by dragging a steel chain over the surface.
 - 3. Concrete floor topping to be tested for compliance with surface flatness and levelness tolerances.
- C. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 035300

SECTION 040110 - MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cleaning the following:

1. Unit masonry surfaces.
2. Stone surfaces.

1.2 ALLOWANCES

- A. Allowances for cleaning masonry are specified in Section 012100 "Allowances."

1.3 DEFINITIONS

- A. Very Low-Pressure Spray: Under [100 psi] <Insert value>.
- B. Low-Pressure Spray: [100 to 400 psi; 4 to 6 gpm] <Insert range of values>.
- C. Medium-Pressure Spray: [400 to 800 psi; 4 to 6 gpm] <Insert range of values>.
- D. High-Pressure Spray: [800 to 1200 psi; 4 to 6 gpm] <Insert range of values>.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
1. Review methods and procedures related to cleaning masonry including, but not limited to, the following:
 - a. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
 - b. Materials, material application, and sequencing.
 - c. Cleaning program.
 - d. Coordination with building occupants.

1.5 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform masonry-cleaning work in the following sequence:
1. Remove plant growth.
 2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.

3. Remove paint.
 4. Clean masonry surfaces.
 5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.
- B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Sections. Patch holes in mortar joints according to masonry repointing Sections.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include material descriptions and application instructions.
 2. Include test data substantiating that products comply with requirements.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For paint-remover manufacturer and chemical-cleaner manufacturer.
- B. Preconstruction Test Reports: For cleaning materials and methods.
- C. Cleaning program.

1.8 QUALITY ASSURANCE

- A. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection[, **preconstruction product testing**,] and on-site assistance.
- B. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection[, **preconstruction product testing**,] and on-site assistance.
- C. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.
1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.
- D. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
1. Cleaning: Clean an area [**approximately 25 sq. ft.**] [**as indicated**] <Insert dimension> for each type of masonry and surface condition.
 - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and

- methods known to have deleterious effect.
- b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

- 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage one or more chemical-cleaner [**and paint-remover**] manufacturers to perform preconstruction testing on masonry surfaces.
 - 1. Use test areas as indicated and representative of proposed materials and existing construction.
 - 2. Propose changes to materials and methods to suit Project.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is **40 deg F** and above and is predicted to remain so for at least seven days after completion of cleaning.

PART 2 - PRODUCTS

2.1 ~~CLEANING MATERIALS~~

- A. ~~Water: Potable.~~
- B. ~~Hot Water: Water heated to a temperature of 140 to 160 deg F.~~
- C. ~~Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.~~
- D. ~~Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.~~

2.22.1 CHEMICAL CLEANING SOLUTIONS

- A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.
- B. Acidic Cleaner Solution for [**Nonglazed Masonry**] [**and**] [**Unpolished Stone**]: Dilute acidic cleaner with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by chemical-cleaner manufacturer.

1. Stones: Use only on unpolished granite, unpolished dolomite marble, and siliceous sandstone.
- C. Acidic Cleaner for **[Glazed Masonry]** **[and]** **[Polished Stone]**: Dilute acidic cleaner with water to concentration demonstrated by testing that does not etch or otherwise damage glazed or polished surface, but not greater than that recommended in writing by chemical-cleaner manufacturer.
 1. Stones: Use only on polished granite and polished dolomite marble.

PART 3 - EXECUTION

3.1 MASONRY-CLEANING SPECIALIST

- A. Masonry-Cleaning Specialist Firms: Subject to compliance with requirements, **[provide masonry cleaning by one of the following]** **[firms that may provide masonry cleaning include, but are not limited to, the following]**:
 1. **<Insert, in separate subparagraphs, names of masonry-cleaning specialist firms>.**

3.2 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
 3. Neutralize alkaline and acid wastes before disposal.
 4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- B. Remove **[gutters and]** downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.
 1. Provide temporary rain drainage during work to direct water away from building.

3.3 CLEANING MASONRY, GENERAL

- A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from **[20 feet]** **[50 feet]** **<Insert distance>** away by Architect.
- B. Proceed with cleaning in an orderly manner; work from **[bottom to top]** **[top to bottom]** of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.
- C. Use only those cleaning methods indicated for each masonry material and location.

1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
 - a. Equip units with pressure gages.
 - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - e. For heated water-spray application, use equipment capable of maintaining temperature between **140 and 160 deg F** at flow rates indicated.
 - f. For steam application, use steam generator capable of delivering live steam at nozzle.
 - D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
 - E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.
 - F. Water Application Methods:
 1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least **6 inches** from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - G. Steam Cleaning: Apply steam to masonry surfaces at the very low pressures indicated for each type of masonry. Hold nozzle at least **6 inches** from masonry surface and apply steam in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - H. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush [or spray] application. [**Do not spray apply at pressures exceeding 50 psi.**] Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
 - I. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
 - J. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.
- 3.4 PRELIMINARY CLEANING
- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose

soil and plant debris from open joints to whatever depth they occur.

- B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.

1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
2. Remove paint and calking with [alkaline paint remover] <Insert requirement>.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Repeat application up to two times if needed.
3. Remove asphalt and tar with [solvent-type paste paint remover] <Insert requirement>.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Apply paint remover only to asphalt and tar by brush without prewetting.
 - c. Allow paint remover to remain on surface for 10 to 30 minutes.
 - d. Repeat application if needed.

3.5 PAINT REMOVAL <Insert drawing designation>

- A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

- B. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
5. Repeat process if necessary to remove all paint.
6. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
7. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.

- C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

7. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
8. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
9. For spots of remaining paint, apply alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.

D. Paint Removal with Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

E. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using [low] [medium] [high]-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

3.6 CLEANING MASONRY <Insert drawing designation>

A. Cold-Water Soak:

1. Apply cold water by intermittent spraying to keep surface moist.
2. Use perforated hoses or other means that apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles of [five minutes] <Insert time> on and [20 minutes] <Insert time> off.
4. Continue spraying [until surface encrustation has softened enough to permit its removal by water wash, as indicated by cleaning tests] [for 72 hours] <Insert requirement>.
5. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by [low] [medium] [high]-pressure spray.

C. Hot-Water Wash: Use hot water applied by [low] [medium] [high]-pressure spray.

D. Steam Cleaning: Apply steam at very low pressures not exceeding [30 psi] [80 psi] <Insert value>. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.

E. Detergent Cleaning:

1. Wet surface with [cold] [hot] water applied by low-pressure spray.

2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 3. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove detergent solution and soil.
 4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
- F. Mold, Mildew, and Algae Removal:
1. Wet surface with [cold] [hot] water applied by low-pressure spray.
 2. Apply mold, mildew, and algae remover by brush [or low-pressure spray].
 3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
 4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove mold, mildew, and algae remover and soil.
 5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
- G. Nonacidic Gel Chemical Cleaning:
1. Wet surface with [cold] [hot] water applied by low-pressure spray.
 2. Apply gel cleaner in **1/8-inch** thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
 3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] **<Insert requirement>**.
 4. Remove bulk of gel cleaner.
 5. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
 6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- H. Nonacidic Liquid Chemical Cleaning:
1. Wet surface with [cold] [hot] water applied by low-pressure spray.
 2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].
 3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] **<Insert requirement>**.
 4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
 5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- I. Mild-Acid Chemical Cleaning:
1. Wet surface with cold water applied by low-pressure spray.
 2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].
 3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] **<Insert requirement>**.
 4. Rinse with cold water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
 5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

J. Acidic Chemical Cleaning:

1. Wet surface with cold water applied by low-pressure spray.
2. Apply cleaner to surface [**in two applications**] by brush [**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**] [**established by mockup**] [**of two to three minutes**] <Insert requirement>.
4. Rinse with cold water applied by [**low**] [**medium**] [**high**]-pressure spray to remove chemicals and soil. Rinse until all foaming, if any, stops and suds disappear.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

K. One-Part Limestone Chemical Cleaning:

1. Wet surface with [**cold**] [**hot**] water applied by low-pressure spray.
2. Apply cleaner to surface by brush [**or low-pressure spray**].
3. Let cleaner remain on surface for period [**recommended in writing by chemical-cleaner manufacturer**] [**established by mockup**] <Insert requirement>.
4. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
5. Rinse with [**cold**] [**hot**] water applied by medium-pressure spray to remove chemicals and soil.

L. Two-Part Chemical Cleaning:

1. Wet surface with [**cold**] [**hot**] water applied by low-pressure spray.
2. Apply alkaline prewash cleaner to surface by brush or roller.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer unless otherwise indicated.
4. Rinse with [**cold**] [**hot**] water applied by medium-pressure spray to remove chemicals and soil.
5. Apply acidic afterwash cleaner to surface [**in two applications**], while surface is still wet, using [**low-pressure spray equipment,**] deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended in writing by manufacturer unless otherwise indicated.
6. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil. [**Rinse until surface reaction value is between pH 5 and pH 9 according to pH-measuring paper, pen, or indicator solution.**]
7. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection [**to perform preconstruction product testing,**] and provide on-site assistance when requested by Architect. Have [**paint-remover manufacturer's and**] chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than [**once**] [**twice**] <Insert requirement> to observing progress and quality of the work.

3.8 FINAL CLEANING

- A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
- B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION 040110

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Concrete masonry units.~~
- ~~2. Lintels.~~
- ~~3. Brick.~~
- ~~4.1. Structural clay facing tile.~~
- ~~5.2. Fireplace and chimney lining units.~~
- ~~6. Mortar and grout materials.~~
- ~~7. Reinforcement.~~
- ~~8.3. Ties and anchors.~~
- ~~9. Embedded flashing.~~
- ~~10. Accessories.~~
- ~~11.4. Mortar and grout mixes.~~

~~B. Products Installed but not Furnished under This Section:~~

- ~~1. Cast-stone trim in unit masonry.~~
- ~~2. Stone trim units in unit masonry.~~
- ~~3. Steel lintels in unit masonry.~~
- ~~4. Steel shelf angles for supporting unit masonry.~~
- ~~5. Cavity wall insulation adhered to masonry backup.~~

~~C.B.~~ Related Requirements:

1. Section 014339 "Mockups" for integrated exterior mockup requirements.
2. Section 019119.43 "Exterior Enclosure Commissioning."
3. Section 031000 "Concrete Forms and Accessories" for [**installing**] dovetail or channel slots for masonry-veneer anchors.
4. Section 042300 "Glass Unit Masonry" for glass block.
5. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
6. Section 044313.13 "Anchored Stone Masonry Veneer" for thin stone trim set as anchored veneer.
7. Section 044313.16 "Adhered Stone Masonry Veneer" for thin stone trim set as adhered veneer.
8. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
9. Section 071900 "Water Repellents" for water repellents applied to unit masonry assemblies.
10. Section 072100 "Thermal Insulation" for cavity wall insulation.
11. Section 076200 "Sheet Metal Flashing and Trim" for [**exposed**] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
12. Section 089516 "Wall Vents" for wall vents (brick vents).
13. Section 096313 "Brick Flooring" for interior brick flooring.
14. Section 096313.35 "Chemical-Resistant Brick Flooring" for chemical-resistant, interior brick flooring.

15. Section 097519 "Stone Trim" for interior stone window stools.
16. Section 321400 "Unit Paving" for exterior unit masonry paving.
17. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 DEFINITIONS

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

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special shapes.
 2. Reinforcing Steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. [**Indicate elevations of reinforced walls.**]
 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 1. Decorative CMUs, in the form of small-scale units.
 2. Pre-faced CMUs.
 3. Concrete face brick, in the form of small-scale units.
 4. **[Clay face] [Hollow] brick[, in the form of straps of five or more bricks].**
 5. Glazed brick.
 6. Glazed structural clay tile.
 7. Colored mortar.
 8. Weep/cavity vents.
- D. Samples for Verification: For each type and color of the following:
 1. **[Exposed] [Decorative]** CMUs.
 2. Pre-faced CMUs.
 3. Concrete face brick.
 4. **[Clay face] [Hollow] brick[, in the form of straps of five or more bricks].**

5. Special brick shapes.
 6. Glazed brick.
 7. Glazed structural clay tile.
 8. Unglazed structural clay tile.
 9. **[Pigmented] [and] [colored-aggregate]** mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 10. Weep/cavity vents.
 11. Cavity drainage material.
 12. Accessories embedded in masonry.
- E. Delegated Design Submittals: For **[masonry anchors and ties]** **<Insert engineered items>**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Sustainable Design Submittals:
1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 2. Environmental Product Declaration (EPD): For each product.
 3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
 4. Environmental Product Declaration: For each product.
 5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
 6. Environmental Product Declaration: For each product.
 7. Environmental Product Declaration: For each product.
 8. Third-Party Certifications: For each product.
 9. Third-Party Certified Life Cycle Assessment: For each product.
 10. Type III Environmental Product Declaration (EPD): For each product.
 11. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Material Certificates: For each type of the following:
1. Masonry units.
 - a. Include **[data on material properties]** **[material test reports substantiating compliance with requirements]**.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
 - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and

thawing in accordance with ASTM C67/C67M [or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability].

- e. For masonry units [used in structural masonry], include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Qualification Statements: For [testing agency].

D. Delegated design engineer qualifications.

E. 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 in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

F. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602.

G. [Cold-Weather] [and] [Hot-Weather] Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installers: All masonry flashing installers must complete the International Masonry Institute Flashing Upgrade training course.
2. Delegated Design Engineer: A professional engineer who is legally qualified to practice in [state] <Insert jurisdiction> where Project is located and who is experienced in providing engineering services of the type indicated.
3. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.8 MOCKUPS

A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for [each type of exposed unit masonry construction] [typical exterior wall] [typical interior wall] [typical exterior and interior walls] in sizes approximately [48 inches] [60 inches] <Insert dimension> long by [36 inches] [48

- inches** <Insert dimension> high [**by full thickness**].
2. Build sample panels facing south.
 3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
 4. Clean [**one-half of**] exposed faces of panels with masonry cleaner indicated.
 5. Protect approved sample panels from the elements with weather-resistant membrane.
 6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.
- B. Wall Mockups: Build mockups [to verify selections made under Sample submittals] [to demonstrate aesthetic effects] [to set quality standards for materials and execution] [and] [to set quality standards for installation]. [See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.]
1. Build mockup [as indicated on Drawings] <Insert mockup requirements>.
 2. Build mockups for [each type of exposed unit masonry construction] [typical exterior wall] [typical interior wall] [typical exterior and interior walls] in sizes approximately [48 inches] [60 inches] [72 inches] [96 inches] <Insert dimension> long by [36 inches] [48 inches] [60 inches] [72 inches] <Insert dimension> high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least **16 inches** long in [each] [exterior wall] mockup.
 - b. Include lower corner of window opening [, framed with stone trim,] at upper corner of exterior wall mockup. Make opening approximately **12 inches** wide by **16 inches** high.
 - c. Include through-wall flashing installed for a **24-inch** length in corner of exterior wall mockup approximately **16 inches** down from top of mockup, with a **12-inch** length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include [metal] [wood] studs, sheathing, [water-resistive barrier] [sheathing joint-and-penetration treatment] [air barrier], veneer anchors, flashing [, cavity drainage material], and weep holes in exterior masonry-veneer wall mockup.
 - e. Include [glazed structural clay tile] [pre-faced CMUs] [clay face brick] on one face of interior unit masonry wall mockup.
 3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 4. Clean [**one-half of**] exposed faces of mockups with masonry cleaner as indicated.
 5. Protect accepted mockups from the elements with weather-resistant membrane.
 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations by Change Order.
 7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have

become damp.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches** down both sides of walls, and hold cover securely in place.
 - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of **24 inches** down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain [exposed masonry units] [cementitious mortar components] [and] [mortar aggregate] from single [source] [producer] [or] [manufacturer].

- B. For **[exposed masonry units]** **[and]** **[cementitious mortar components]**, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **<Insert engineered items>**.
- B. Seismic Performance: Masonry to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** **<Insert requirement>**.
- C. Provide **[structural]** unit masonry that develops indicated net-area compressive strengths at 28 days.
1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602.
 2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602, 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 **[and will be within 20 ft. vertically and horizontally of a walking surface]**.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
1. Where fire-resistance-rated construction is indicated, **[use the equivalent thickness method for masonry units in accordance with ACI 216.1]** **[units are listed by UL or a qualified testing agency acceptable to authorities having jurisdiction]**.

2.4 ~~CONCRETE MASONRY UNITS~~

- A. ~~Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates **[and cement]** that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.~~
- B. ~~Regional Materials: CMUs shall be manufactured within 500 miles of Project site.~~
- C. ~~Regional Materials: CMUs shall be manufactured within 100 miles of Project site from aggregates **[and cement]** that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.~~
- D. ~~Indigenous Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates **[and cement]** that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.~~
- E. ~~Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates **[and cement]** that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.~~

F. — 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.
2. — Provide ~~[square-edged]~~ ~~[bullnose]~~ units for outside corners unless otherwise indicated.

G. — CMUs: ASTM C90, ~~[normal weight]~~ ~~[medium weight]~~ ~~[lightweight]~~ ~~[unless otherwise indicated]~~.

1. — Unit Compressive Strength: Provide units with minimum average net-area compressive strength of ~~[2150 psi]~~ ~~[2800 psi]~~ ~~[3050 psi]~~ ~~<Insert value>~~.
2. — Size (Width): Manufactured to dimensions ~~3/8 inch~~ less than nominal dimensions.
3. — Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
4. — Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

H. — Concrete Building Brick: ASTM C55, ~~[normal weight]~~ ~~[medium weight]~~ ~~[lightweight]~~ ~~[unless otherwise indicated]~~.

1. — Unit Compressive Strength: Provide units with minimum average net-area compressive strength of ~~[2800 psi]~~ ~~[3050 psi]~~ ~~[3750 psi]~~ ~~[4050 psi]~~ ~~<Insert value>~~.
2. — Size (Actual Dimensions): ~~3-5/8 inches~~ wide by ~~[2-1/4 inches]~~ ~~[2-3/4 inches]~~ ~~[3-5/8 inches]~~ high by ~~7-5/8 inches~~ long.

2.5 — LINTELS

A. — Solid Concrete Masonry Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. ~~[Provide lintels with net-area compressive strength of not less than that of CMUs.]~~

B. — Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 032000 "Concrete Reinforcing," and with reinforcing bars indicated.

C. — Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 — BRICK

A. — Regional Materials: Brick shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.

B. — Regional Materials: Brick shall be manufactured within **500 miles** of Project site.

C. — Regional Materials: Brick shall be manufactured within **100 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.

D. — Indigenous Materials: Brick shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

E. — Regional Materials: Brick shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested,

or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. ~~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 stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels] [requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing] [where shapes produced by sawing would result in sawed surfaces being exposed to view].~~

G. ~~Building (Common) Brick: ASTM C62, [Grade SW] [Grade MW or Grade SW] [Grade NW, Grade MW, or Grade SW].~~

1. ~~Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [1700 psi] [2100 psi] [3350 psi] [4150 psi] [4950 psi] [6200 psi] [6600 psi] <Insert value>.~~
2. ~~Size (Actual Dimensions): [3-1/2 inches wide by 2-1/4 inches high by 7-1/2 inches long] [or] [3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long] <Insert dimensions>.~~
3. ~~Application: Use where brick is indicated for concealed locations. [Face brick complying with requirements for grade, compressive strength, and size indicated for building brick may be substituted for building brick.]~~

H. ~~Hollow Brick: ASTM C652, [Grade SW] [Grade MW or Grade SW], [Class H40V (void areas between 25 and 40 percent of gross cross-sectional area)] [Class H60V (void areas between 40 and 60 percent of gross cross-sectional area)], [Type HBX] [Type HBS] [Type HBA] [Type HBB].~~

1. ~~Basis-of-Design Product: <Insert manufacturer's name; product name or designation>.~~
2. ~~Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [3350 psi] [4150 psi] [4950 psi] [6200 psi] [6600 psi] [8250 psi] <Insert value>.~~
3. ~~Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."~~
4. ~~Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from 10 ft. [or have a history of successful use in Project's area].~~
5. ~~Size (Actual Dimensions): [5-1/2 inches] [5-5/8 inches] [7-1/2 inches] [7-5/8 inches] <Insert dimension> wide by [3-1/2 inches] [3-5/8 inches] <Insert dimension> high by [11-1/2 inches] [11-5/8 inches] [15-1/2 inches] [15-5/8 inches] <Insert dimension> long.~~
6. ~~Application: Use where brick is exposed unless otherwise indicated.~~
7. ~~[Where shown to "match existing,"]provide hollow brick matching color range, texture, and size of existing adjacent brickwork.~~

a. ~~<Insert information on existing brick if known>.~~

8. ~~Color and Texture: [Medium brown, wire cut] [Full-range red, smooth texture] [Buff, velour] <Insert color and texture> [Match Architect's samples] [As selected by Architect].~~

2.72.4 STRUCTURAL CLAY FACING TILE

A. General:

1. Provide solid, multicored, or hollow units, with shape and direction of cores optional unless otherwise indicated.
 2. Where reinforced masonry is indicated, provide multicored units designed for use in reinforced, grouted masonry, either with vertical cores and with webs notched to receive horizontal reinforcement, or with horizontal cores and with holes in bed shells for placement of grout and to receive vertical reinforcement.
 3. Where indicated for exterior applications, provide units recommended by manufacturer for exterior use in Project's location.
 4. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated, including applications that cannot be produced by sawing standard units.
 - a. Provide **[bullnose]** **[square-edged]** units for outside corners unless otherwise indicated.
 - b. Provide coved internal corners.
 - c. Provide recessed, coved base units.
 5. Where direct application of plaster is indicated or where bonded to backup masonry, provide units with rough, combed, or scored faces.
- B. Glazed Structural Clay Facing Tile: ASTM C126, **[Grade S (Select)]** **[Grade SS (Select Sized or Ground Edge)]**.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Sizes: **[6P Series with actual face dimensions of 3-5/8 inches high by 11-5/8 inches]** **[6T Series with actual face dimensions of 5 inches high by 11-11/16 inches]** **[4W Series (8-Square) with actual face dimensions of 7-5/8 inches high by 7-5/8 inches]** **[8W Series with actual face dimensions of 7-5/8 inches high by 15-5/8 inches]** **<Insert dimension>** long by widths indicated.
 3. Width: Manufactured to dimensions **[5/16 inch]** **[3/8 inch]** less than nominal dimensions.
 4. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
 5. Provide special units glazed on ends and tops, as well as faces for corners, jambs, sills, pilasters, columns, and other applications indicated, where glazed units are exposed on other surfaces and faces.
 6. Colors and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]**.
 7. **[Where shown to "match existing,"]** provide glazed structural clay tile matching color range, texture, and size of existing adjacent glazed structural clay tile.
 - a. **<Insert information on existing glazed structural clay tile if known>**.
- C. Unglazed Structural Clay Facing Tile: ASTM C212, **[Type FTX]** **[Type FTS]**, **[Standard Class]** **[Special-Duty Class]**.
1. Basis-of-Design Product: **<Insert manufacturer's name; product name or designation>**.
 2. Number of Faces: Single faced[, **where only one finished face is exposed when units are installed; double faced, where both finished faces are exposed when units are installed**].
 3. Size: **[As indicated]** **[Match existing]** **<Insert size>**.

2.82.5 FIREPLACE AND CHIMNEY LINING UNITS

- A. Firebox Brick: ASTM C1261, size required to produce lining thickness indicated.
- B. Clay Flue Lining Units: ASTM C315.

2.9 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Aggregate for mortar and grout [~~cement, and lime~~] shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site.
- B. Regional Materials: Aggregate for mortar and grout [~~cement, and lime~~] shall be manufactured within ~~500 miles~~ of Project site.
- C. Regional Materials: Aggregate for mortar and grout [~~cement, and lime~~] shall be manufactured within ~~100 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~100 miles~~ of Project site.
- D. Indigenous Materials: Aggregate for mortar and grout [~~cement, and lime~~] shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- E. Regional Materials: Aggregate for mortar and grout [~~cement, and lime~~] shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Portland Cement: ASTM C150/C150M, 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.
1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.
- G. Hydrated Lime: ASTM C207, Type S.
- H. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- I. Colored Cement Products: Packaged blend made from [~~portland cement and hydrated lime~~] [~~or~~] [~~masonry cement~~] and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
2. Pigments do not exceed 10 percent of portland cement by weight.
3. Pigments do not exceed 5 percent of [~~masonry cement~~] [~~or~~] [~~mortar cement~~] by weight.
- J. Problended Dry Mortar Mix: Packaged blend made from [~~portland cement and hydrated lime~~] [~~masonry cement~~] [~~or~~] [~~mortar cement~~], sand, [~~mortar pigments~~], [~~water repellents~~], and admixtures and complying with ASTM C1714/C1714M.
- K. Aggregate for Mortar: ASTM C144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than **1/4 inch** thick, use aggregate graded with 100 percent passing the **No. 16** sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- L. Aggregate for Grout: ASTM C404.
- M. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from

manufacturer's colors.

N. — Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C199 test; or an equivalent product acceptable to authorities having jurisdiction.

O. — Water: Potable.

2.10 — REINFORCEMENT

A. — Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60**.

B. — Masonry-Joint Reinforcement, General: ASTM A951/A951M.

1. — Interior Walls: ~~[Mill]~~ **[Hot-dip]** galvanized carbon steel.
2. — Exterior Walls: ~~[Hot-dip galvanized carbon]~~ **[Stainless]** steel.
3. — Wire Size for Side Rods: ~~[0.148-inch]~~ **[0.187-inch]** diameter.
4. — Wire Size for Cross Rods: ~~[0.148-inch]~~ **[0.187-inch]** diameter.
5. — Wire Size for Veneer Ties: ~~[0.148-inch]~~ **[0.187-inch]** diameter.
6. — Spacing of Cross Rods, Tabs, and Cross Ties: Not more than **16 inches** o.c.
7. — Provide in lengths of not less than **10 ft.**, ~~[with prefabricated corner and tee units]~~.

C. — Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single **0.187-inch** diameter, ~~[hot-dip galvanized carbon]~~ **[stainless]** steel continuous wire.

2.11 — TIES AND ANCHORS

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

B. — Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. — Mill-Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A641/A641M, Class 1 coating.
2. — Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
3. — Stainless Steel Wire: ASTM A580/A580M, **[Type 304]** **[Type 316]**.
4. — Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **G60** zinc coating.
5. — Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. — Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, **[Type 304]** **[Type 316]**.
7. — Steel Plates, Shapes, and Bars: ASTM A36/A36M.
8. — Stainless Steel Bars: ASTM A276 or ASTM A666, Type 304.

C. — Corrugated-Metal Ties: Metal strips not less than **7/8 inch** wide with corrugations having a wavelength of **0.3 to 0.5 inch** and an amplitude of **0.06 to 0.10 inch** made from ~~[0.0336-inch-thick steel sheet, galvanized after fabrication]~~ **[0.0635-inch-thick steel sheet, galvanized after fabrication]** ~~[0.0312-inch-thick, stainless steel sheet]~~ **[0.0625-inch-thick, stainless steel sheet]**.

D. — Individual Wire Ties: Rectangular units with closed ends and not less than **4 inches** wide.

1. — Z-shaped ties with ends bent 90 degrees to provide hooks not less than **2 inches** long for masonry constructed from solid

- units.
2. ~~Where wythes [do not align] [are of different materials], use adjustable ties with pintle and eye connections having a maximum adjustment of 1-1/4 inches.~~
 3. ~~Wire: Fabricate from [3/16-inch] [1/4-inch] diameter, [hot-dip galvanized steel] [stainless steel] wire. [Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.]~~
- E. ~~Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.~~
1. ~~Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, [hot-dip galvanized steel] [stainless steel] wire. [Mill-galvanized wire may be used at interior walls unless otherwise indicated.]~~
 2. ~~Tie Section: Triangular-shaped wire tie made from [0.187-inch] [0.25-inch] diameter, [hot-dip galvanized steel] [stainless steel] wire. [Mill-galvanized wire may be used at interior walls unless otherwise indicated.]~~
- F. ~~Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.~~
1. ~~Connector Section: [Dovetail] [Channel] tabs for inserting into [dovetail] [channel] slots in concrete and attached to tie section; formed from [0.060-inch-thick steel sheet, galvanized after fabrication] [0.105-inch-thick steel sheet, galvanized after fabrication] [0.062-inch-thick, stainless steel sheet] [0.109-inch-thick, stainless steel sheet].~~
 - a. ~~[0.064-inch] [0.108-inch] thick, galvanized steel sheet may be used at interior walls unless otherwise indicated.~~
 2. ~~Tie Section: Triangular-shaped wire tie made from [0.187-inch] [0.25-inch] diameter, [hot-dip galvanized steel] [stainless steel] wire. [Mill-galvanized wire may be used at interior walls unless otherwise indicated.]~~
 3. ~~Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from [0.0635-inch-thick steel sheet, galvanized after fabrication] [0.0785-inch-thick steel sheet, galvanized after fabrication] [0.1084-inch-thick steel sheet, galvanized after fabrication] [0.0625-inch-thick, stainless steel sheet] [0.0781-inch-thick, stainless steel sheet] [0.1094-inch-thick, stainless steel sheet] with [dovetail] [channel] tabs for inserting into slots in concrete.~~
 - a. ~~[0.064-inch] [0.079-inch] [0.108-inch] thick galvanized sheet may be used at interior walls unless otherwise indicated.~~
- G. ~~Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [steel, hot-dip galvanized after fabrication] [stainless steel].~~
- H. ~~Rigid Anchors: Fabricate from steel bars [1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated] [bent to configuration indicated].~~
1. ~~Corrosion Protection: [Hot-dip galvanized to comply with ASTM A153/A153M] [Epoxy coating 0.020 inch thick] [Rust-inhibitive paint].~~
- I. ~~Adjustable Masonry Veneer Anchors:~~
1. ~~General: Provide anchors that allow vertical adjustment but resist a 100 lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.~~
 2. ~~Fabricate sheet metal anchor sections and other sheet metal parts from [0.0785-inch-thick steel sheet, galvanized after~~

~~fabrication] [0.1084-inch-thick steel sheet, galvanized after fabrication] [0.0781-inch-thick, stainless steel sheet]
[0.1094-inch-thick, stainless steel sheet].~~

3. ~~Fabricate wire ties from [0.187-inch] [0.25-inch] diameter, [hot-dip galvanized steel] [stainless steel] wire unless otherwise indicated.~~
4. ~~Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.~~
5. ~~Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours in accordance with ASTM B117.~~
6. ~~Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300-Series stainless steel shank.~~

2.12 EMBEDDED FLASHING

- A. ~~Flexible Flashing: Use [one of] the following unless otherwise indicated:~~
- B. ~~Solder and Sealants for Sheet Metal Flashings: [As specified in Section 076200 "Sheet Metal Flashing and Trim."]~~
 1. ~~Solder for Stainless Steel: ASTM B32, [Grade Sn60] [Grade Sn96], with acid flux of type recommended by stainless steel sheet manufacturer.~~
 2. ~~Solder for Copper: ASTM B32, [Grade Sn50] [with maximum lead content of 0.2 percent].~~
 3. ~~Elastomeric Sealant: ASTM C920, chemically curing [urethane] [polysulfide] [silicone] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.~~
- C. ~~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.~~
- D. ~~Termination Bars for Flexible Flashing: [Aluminum] [Stainless steel] [Rigid PVC] bars [0.075 inch by 1 inch] [1/8 inch by 1 inch] [1/8 inch by 1-1/8 inch].~~
- E. ~~Termination Bars for Flexible Flashing, Flanged: [Stainless steel sheet 0.019 inch by 1-1/2 inches] [Aluminum sheet 0.064 inch by 1-1/2 inches] with a 3/8-inch flange at top [and bottom].~~

2.13 ACCESSORIES

- A. ~~Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [neoprene] [urethane] [or] [PVC].~~
- B. ~~Preformed Control-Joint Gaskets: Made from [styrene-butadiene rubber compound, complying with ASTM D2000, Designation M2AA-805] [or] [PVC, complying with ASTM D2287, Type PVC-65406] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.~~
- C. ~~Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).~~
- D. ~~Weep/Cavity Vents: Use [one of] the following unless otherwise indicated:~~
 1. ~~Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch~~

- exposure on exterior and **18 inches** in cavity. Use only for weeps.
2. ~~Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch OD by 4 inches long.~~
 3. ~~Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.~~
- E. ~~Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.~~
- F. ~~Masonry Cell Fill: [Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation)] [Lightweight-Aggregate Fill: ASTM C331/C331M] [Foamed-in-place masonry cell fill].~~

2.142.6 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] [masonry cement] [or] [mortar cement] mortar unless otherwise indicated.
 3. For exterior masonry, use [portland cement-lime] [masonry cement] [or] [mortar cement] mortar.
 4. For reinforced masonry, use [portland cement-lime] [masonry cement] [or] [mortar 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.
- C. Mortar for Unit Masonry: Comply with ASTM C270, [Proportion] [Property] Specification. Provide the following types of mortar for applications stated unless another type is indicated [or needed to provide required compressive strength of masonry].
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use [Type M] [Type S] [Type N].
 3. For mortar parge coats, use [Type S] [or] [Type N].
 4. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Pigmented Mortar: Use colored cement product [or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products].
1. Pigments do not exceed 10 percent of portland cement by weight.
 2. Pigments do not exceed 5 percent of [masonry cement] [or] [mortar cement] by weight.
 3. Mix to match Architect's sample.
 4. Application: Use pigmented mortar for exposed mortar joints with the following units: <Insert masonry unit types>.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Architect's sample.
 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units: <Insert masonry unit types>.

- F. Grout for Unit Masonry: Comply with ASTM C476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C476, [Table 1] [or] [paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi].
 - 3. Provide grout with a slump of [8 to 11 inches] [10 to 11 inches] as measured in accordance with ASTM C143/C143M.
- G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
 - 1. Application: Use epoxy pointing mortar for exposed mortar joints with the following units: <Insert masonry unit types>.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds **30 g/30 sq. in.** per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

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

B. Lines and Levels:

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

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**, with a maximum thickness limited to **1/2 inch**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch** or minus **1/4 inch**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**. [Do not vary from adjacent bed-joint and head-joint thicknesses by more than **1/8 inch**.]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch** from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [running bond] [stack bond] [one-third running bond] [Flemish bond] [English bond] [bond pattern indicated on Drawings]; do not use units with less-than-nominal **4-inch**

horizontal face dimensions at corners or jambs.

- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than [2 inches] [4 inches]. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors, and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors [48 inches] <Insert spacing> o.c. unless otherwise indicated.
 - 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay [CMUs] [and] [hollow brick] 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.
 - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- 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** thick joints.
- D. Set firebox brick in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately **1/8 inch**. Tool joints smooth on surfaces exposed to fire or smoke.
- E. Install clay flue liners to comply with ASTM C1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar **1/16 to 1/8 inch** thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.
- F. Set **[stone]** **[cast-stone]** trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Allow cleaned surfaces to dry before setting.
 3. Wet joint surfaces thoroughly before applying mortar.
 4. Rake out mortar joints for pointing with sealant.
- G. Rake out mortar joints at **[pre-faced CMUs]** **[glazed brick]** **[and]** **[glazed structural clay tile]** to a uniform depth of **1/4 inch** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- H. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
1. For glazed masonry units, use a nonmetallic jointer **3/4 inch** or more in width.
- I. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- J. Cut joints flush where indicated to receive **[waterproofing]** **[cavity wall insulation]** **[air barriers]** unless otherwise indicated.

3.6 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together **[using one of the following methods]** **[as follows]**:
1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for **[4.5 sq. ft.]** **[2.67 sq. ft.]** **[1.77 sq. ft.]** of wall area spaced not to exceed **[36 inches]** **[24 inches]** **[16 inches]** o.c. horizontally and **16 inches** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches** of openings and space not more than **36 inches** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches** o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
 2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use **[ladder-type reinforcement extending across both wythes]** **[tab-type reinforcement]**.

- b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**].
- 3. Header Bonding: Provide masonry unit headers extending not less than **3 inches** into each wythe. Space headers not more than **[8 inches] [12 inches]** clear horizontally and **16 inches** clear vertically.
- B. Bond wythes of composite masonry together using bonding system indicated on Drawings.
- C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- D. Collar Joints in Clay Tile Masonry: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at **[exterior walls, except cavity walls] [, and] [interior walls and partitions]**.
- E. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
 - 1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- F. Intersecting and Abutting Walls: Unless vertical expansion or control joints are indicated at juncture, bond walls together as follows:
 - 1. Provide individual metal ties not more than **[8 inches] [16 inches]** o.c.
 - 2. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
 - 3. Provide rigid metal anchors not more than **[24 inches] [48 inches]** o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together [**using one of the following methods**] [**as follows**]:
 - 1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for **[4.5 sq. ft.] [2.67 sq. ft.] [1.77 sq. ft.]** of wall area spaced not to exceed **[36 inches] [24 inches] [16 inches]** o.c. horizontally and **16 inches** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches** of openings and space not more than **36 inches** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches** o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.
 - 2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use **[ladder-type reinforcement extending across both wythes] [tab-type reinforcement]**.
 - b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**].
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement [**with continuous horizontal wire in facing wythe attached to ties**] to allow for differential movement regardless of whether bed joints align.

3. Header Bonding: Provide masonry unit headers extending not less than **3 inches** into each wythe. Space headers not more than **[8 inches] [12 inches]** clear horizontally and **16 inches** clear vertically.
 4. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- D. Parge cavity face of backup wythe in a single coat approximately **3/8 inch** thick. Trowel face of parge coat smooth.
- E. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately **12 inches** o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.
1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to **[wall framing] [and] [concrete and masonry backup]** with **[seismic]** masonry-veneer anchors to comply with the following requirements:
1. Fasten **[screw-attached] [and] [seismic]** anchors **[through sheathing to wall framing] [and] [to concrete and masonry backup]** with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed **[tie sections] [connector sections and continuous wire]** in masonry joints.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Space anchors as indicated, but not more than **18 inches** o.c. vertically and **24 inches** o.c. horizontally, with not less than one anchor for each **2 sq. ft.** of wall area. Install additional anchors within **12 inches** of openings and at intervals, not exceeding **8 inches**, around perimeter.
 5. Space anchors as indicated, but not more than **16 inches** o.c. vertically and **25 inches** o.c. horizontally, with not less than one anchor for each **[2.67 sq. ft.] [3.5 sq. ft.]** of wall area. Install additional anchors within **12 inches** of openings and at intervals, not exceeding **36 inches**, around perimeter.
 6. Space anchors as indicated, but not more than **18 inches** o.c. vertically and horizontally. Install additional anchors within **12 inches** of openings and at intervals, not exceeding **24 inches**, around perimeter.
- B. Provide not less than **[2 inches] [1 inch] <Insert distance>** of airspace between back of masonry veneer and face of **[sheathing] [insulation]**.
1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.9 MASONRY-CELL FILL

- A. Pour **[loose-fill insulation] [lightweight-aggregate fill]** into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 ft.**

- B. Install molded-polystyrene insulation units into masonry unit cells before laying units.
- C. Drill holes in mortar bed joints at spacing as indicated by foamed-in-place masonry fill manufacturer, and inject foam to fill masonry cell voids.

3.10 MASONRY JOINT REINFORCEMENT

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

3.113.10 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than [**1/2 inch**] [**1 inch**] [**2 inches**] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than **24 inches** o.c. vertically and **36 inches** o.c. horizontally.

3.123.11 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry [as follows] [using one of the following methods]:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

- C. Form expansion joints in brick as follows:
1. Build flanges of metal expansion strips into masonry. Lap each joint **4 inches** in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than **[3/8 inch] [1/2 inch]** **<Insert minimum width>** for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than **[3/8 inch]** **<Insert minimum width>**.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.13 — LINTELS

- A. ——— ~~Install steel lintels where indicated.~~
- B. ——— ~~Provide [concrete] [masonry] [or] [offset angle support] lintels where indicated and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are indicated without structural steel or other supporting lintels.~~
- C. ——— ~~Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.~~

3.143.12 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 multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of **[4 inches] [8 inches]**, and through inner wythe to within **1/2 inch** of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately **2 inches** on interior face.
 3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of **[4 inches] [8 inches]**, and **1-1/2 inches** into the inner wythe. **[Form 1/4-inch hook in edge of flashing embedded in inner wythe.]**
 4. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches**; with upper edge tucked under **[water-resistive barrier] [air barrier]**, lapping at least **4 inches**. **[Fasten upper edge of flexible flashing to sheathing through termination bar.]**
 5. At lintels and shelf angles, extend flashing **6 inches** minimum **[, to edge of next full unit]** at each end. At heads and sills, extend flashing **6 inches** minimum **[, to edge of next full unit]** and turn ends up not less than **2 inches** to form end dams.
 6. Interlock end joints of sawtooth sheet metal flashing by overlapping ribs not less than **1-1/2 inches** or as recommended by

- flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
7. Install metal [drip edges] [and] [sealant stops] with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.
- E. 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] [or] [open-head joints] to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes **24 inches** o.c. unless otherwise indicated.
 4. Space weep holes formed from [plastic tubing] [or] [wicking material] **16 inches** o.c.
 5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 6. Trim wicking material flush with outside face of wall after mortar has set.
- F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches**, to maintain drainage.
1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than **24 inches** above top of pea gravel.
- G. Place cavity drainage material in [cavities] [airspace behind veneers] to comply with configuration requirements for cavity drainage material in "Accessories" Article.
- H. Install cavity vents in head joints in exterior wythes at spacing indicated. Use [specified weep/cavity vent products] [or] [open-head joints] 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.

3.153.13 REINFORCED UNIT MASONRY

- 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.
- 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 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] [12.67 ft.] <Insert height>.

3.163.14 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections. 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 will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with [Level 2] [Level 3] in TMS 402.
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. of wall area or portion thereof.
- E. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.
- G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- H. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for [mortar air content] [and] [compressive strength].
- I. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.
- J. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [7 days and at] 28 days.

3.173.15 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. 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**. 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.

3.183.16 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - 7. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

3.193.17 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than **4 inches** in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within **18 inches** of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Concrete masonry units.~~
- ~~2.1. Decorative concrete masonry units.~~
- ~~3.2. Pre-faced concrete masonry units.~~
- ~~4.3. Mortar and grout.~~
- ~~5.4. Steel reinforcing bars.~~
- ~~6.5. Masonry-joint reinforcement.~~
- ~~7.6. Embedded flashing.~~
- ~~8.7. Miscellaneous masonry accessories.~~
- ~~9.8. Masonry-cell fill.~~

~~B. Products Installed but not Furnished under This Section:~~

- ~~1. Cast-stone trim in concrete unit masonry.~~

~~C.B.~~ Related Requirements:

- 1. Section 031000 "Concrete Forms and Accessories" for [installing] dovetail slots for masonry anchors.
- 2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
- 3. Section 071900 "Water Repellents" for water repellents applied to unit masonry assemblies.
- 4. Section 076200 "Sheet Metal Flashing and Trim" for [exposed] sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
- 5. Section 089516 "Wall Vents" for wall vents (brick vents).
- 6. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

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

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 - 2. Environmental Product Declaration (EPD): For each product.
 - 3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
 - 4. Environmental Product Declaration: For each product.
 - 5. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
 - 6. Environmental Product Declaration: For each product.
 - 7. Environmental Product Declaration: For each product.
 - 8. Third-Party Certifications: For each product.
 - 9. Third-Party Certified Life Cycle Assessment: For each product.
 - 10. Type III Environmental Product Declaration (EPD): For each product.
 - 11. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
- C. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. [**Show elevations of reinforced walls.**]
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- D. Samples for Initial Selection:
 - 1. Decorative CMUs, in the form of small-scale units.
 - 2. Pre-faced CMUs.
 - 3. Colored mortar.
 - 4. Weep holes/vents.
- E. Samples for Verification: For each type and color of the following:
 - 1. **[Exposed] [Decorative]** CMUs.
 - 2. Pre-faced CMUs.
 - 3. **[Pigmented] [and] [colored-aggregate]** mortar. Make Samples using same sand and mortar ingredients to be used on Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:

1. Masonry units.
 - a. Include **[data on material properties]** **[material test reports substantiating compliance with requirements]**.
 - b. For masonry units **[used in structural masonry]**, include data and calculations establishing average net-area compressive strength of units.
 2. Integral water repellant used in CMUs.
 3. Cementitious materials. Include name of manufacturer, brand name, and type.
 4. Mortar admixtures.
 5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 6. Grout mixes. Include description of type and proportions of ingredients.
 7. Reinforcing bars.
 8. Joint reinforcement.
 9. Anchors, ties, and metal accessories.
- C. 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 in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602/ACI 530.1/ASCE 6.
- E. Cold-Weather **[and Hot-Weather]** Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
- 1.6 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.
- B. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
1. Build sample panels for **[each type of exposed unit masonry construction]** **[typical exterior wall]** **[typical interior wall]** **[typical exterior and interior walls]** in sizes approximately **[48 inches]** **[60 inches]** **<Insert dimension>** long by **[36 inches]** **[48 inches]** **<Insert dimension>** high **[by full thickness]**.
 2. Build sample panels facing south.
 3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
 4. Protect approved sample panels from the elements with weather-resistant membrane.
 5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.

- C. 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 mockup [**of typical wall area**] as shown on Drawings.
 2. Build mockups for [**each type of exposed unit masonry construction**] [**typical exterior wall**] [**typical interior wall**] [**typical exterior and interior walls**] in sizes approximately [**48 inches**] [**60 inches**] [**72 inches**] [**96 inches**] <Insert dimension> long by [**36 inches**] [**48 inches**] [**60 inches**] [**72 inches**] <Insert dimension> high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least **16 inches** long in [**each**] [**exterior wall**] mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately **12 inches** wide by **16 inches** high.
 - c. Include through-wall flashing installed for a **24-inch** length in corner of exterior wall mockup approximately **16 inches** down from top of mockup, with a **12-inch** length of flashing left exposed to view (omit masonry above half of flashing).
 3. Protect accepted mockups from the elements with weather-resistant membrane.
 4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of **24 inches** down both sides of walls, and hold cover securely in place.

- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

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

2.2 PERFORMANCE REQUIREMENTS

- A. Provide[**structural**] unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602/ACI 530.1/ASCE 6.
 - 2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 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 [**and will be within 20 feet vertically and horizontally of a walking surface**].

- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
1. Where fire-resistance-rated construction is indicated, units are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. Regional Materials: CMUs shall be manufactured within **500 miles** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- B. Regional Materials: CMUs shall be manufactured within **500 miles** of Project site.
- C. Regional Materials: CMUs shall be manufactured within **100 miles** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- D. Indigenous Materials: CMUs shall be manufactured within **500 miles** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- E. Regional Materials: CMUs shall be manufactured within **500 miles** of Project site from aggregates [**and cement**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. 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.
2. Provide [**square-edged**] [**bullnose**] units for outside corners unless otherwise indicated.
- G. CMUs: ASTM C90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [**2150 psi**] [**2800 psi**] [**3050 psi**] <Insert value>.
2. Density Classification: [**Lightweight**] [**Medium weight**] [**Normal weight**] [**unless otherwise indicated**].
3. Size (Width): Manufactured to dimensions **3/8 inch** less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
- H. Concrete Building Brick: ASTM C55.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [**2800 psi**] [**3050 psi**] [**3750 psi**] [**4050 psi**] <Insert value>.
2. Density Classification: [**Lightweight**] [**Medium weight**] [**Normal weight**].
3. Size (Actual Dimensions): **3-5/8 inches** wide by [**2-1/4 inches**] [**2-3/4 inches**] [**3-5/8 inches**] high by **7-5/8 inches** long.

2.52.4 [CONCRETE] [AND] [MASONRY] LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels Matching CMU in Color, Texture: ASTM C1623, matching density classification; and with reinforcing bars indicated. [Provide lintels with net-area compressive strength not less than that of CMUs.]
- C. Precast or Formed-in-Place Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 032000 "Concrete Reinforcing," and with reinforcing bars indicated.
- D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Aggregate for mortar and grout [cement, and lime] shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Regional Materials: Aggregate for mortar and grout [cement, and lime] shall be manufactured within 500 miles of Project site.
- C. Regional Materials: Aggregate for mortar and grout [cement, and lime] shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- D. Indigenous Materials: Aggregate for mortar and grout [cement, and lime] shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- E. Regional Materials: Aggregate for mortar and grout [cement, and lime] shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Portland Cement: ASTM C150/C150M, 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.
 - 1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.
- G. Hydrated Lime: ASTM C207, Type S.
- H. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- I. Colored Cement Products: Packaged blend made from [portland cement and hydrated lime] [masonry cement] [or] [mortar cement] and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 - 2. Pigments does not exceed 10 percent of portland cement by weight.
 - 3. Pigments does not exceed 5 percent of [masonry cement] [or] [mortar cement] by weight.

J. — Aggregate for Mortar: ASTM C144.

1. — For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. — For joints less than **1/4 inch** thick, use aggregate graded with 100 percent passing the **No. 16** sieve.
3. — White-Mortar Aggregates: Natural white sand or crushed white stone.
4. — Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

K. — Aggregate for Grout: ASTM C404.

L. — Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

M. — Water: Potable.

2.7 — REINFORCEMENT

A. — Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60**.

B. — Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. — Interior Walls: [~~Mill~~] [~~Hot-dip~~] galvanized carbon steel.
2. — Exterior Walls: [~~Hot-dip galvanized carbon~~] [~~Stainless~~] steel.
3. — Wire Size for Side Rods: [~~0.148-inch~~] [~~0.187-inch~~] diameter.
4. — Wire Size for Cross Rods: [~~0.148-inch~~] [~~0.187-inch~~] diameter.
5. — Spacing of Cross Rods: Not more than **16 inches** o.c.
6. — Provide in lengths of not less than **10 feet** [~~, with prefabricated corner and tee units~~].

2.82.5 TIES AND ANCHORS

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

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, [**Type 304**] [**Type 316**].
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, **60** zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304**] [**Type 316**].
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch** diameter, [~~hot-dip galvanized steel~~] [~~stainless steel~~] wire. [

- ~~Mill-galvanized wire may be used at interior walls unless otherwise indicated.~~
2. Tie Section: Triangular-shaped wire tie made from ~~[0.187-inch]~~ **[0.25-inch]** diameter, ~~[hot-dip galvanized steel]~~ **[stainless steel]** wire. ~~[Mill-galvanized wire may be used at interior walls unless otherwise indicated.]~~
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from ~~[0.060-inch- thick steel sheet, galvanized after fabrication]~~ **[0.105-inch- thick steel sheet, galvanized after fabrication]** ~~[0.062-inch-thick, stainless steel sheet]~~ **[0.109-inch- thick, stainless steel sheet]**.
 - a. ~~[0.064-inch]~~ **[0.108-inch]** thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.
 2. Tie Section: Triangular-shaped wire tie made from ~~[0.187-inch]~~ **[0.25-inch]** diameter, ~~[hot-dip galvanized steel]~~ **[stainless steel]** wire. ~~[Mill-galvanized wire may be used at interior walls unless otherwise indicated.]~~
 3. Corrugated-Metal Ties: Metal strips not less than **7/8 inch** wide with corrugations having a wavelength of **0.3 to 0.5 inch** and an amplitude of **0.06 to 0.10 inch** made from ~~[0.060-inch- thick steel sheet, galvanized after fabrication]~~ **[0.075-inch-thick steel sheet, galvanized after fabrication]** ~~[0.105-inch- thick steel sheet, galvanized after fabrication]~~ **[0.062-inch- thick, stainless steel sheet]** ~~[0.078-inch- thick, stainless steel sheet]~~ **[0.109-inch- thick, stainless steel sheet]** with dovetail tabs for inserting into dovetail slots in concrete.
 - a. ~~[0.064-inch]~~ **[0.079-inch]** ~~[0.108-inch]~~ thick, galvanized sheet may be used at interior walls unless otherwise indicated.
- E. Partition Top Anchors: **0.105-inch-** thick metal plate with a **3/8-inch-** diameter metal rod **6 inches** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from ~~[steel, hot-dip galvanized after fabrication]~~ **[stainless steel]**.
- F. Rigid Anchors: Fabricate from steel bars **[1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated]** ~~[bent to configuration indicated]~~.
1. Corrosion Protection: ~~[Hot-dip galvanized to comply with ASTM A 153/A153M]~~ **[Epoxy coating 0.020 inch thick]** ~~[Rust-inhibitive paint]~~.

2.9 ~~EMBEDDED FLASHING MATERIALS~~

A. ~~Flexible Flashing: Use~~ **[one of]** the following unless otherwise indicated:

B. ~~Application: Unless otherwise indicated, use the following:~~

1. ~~Where flashing is indicated to receive counterflashing, use metal flashing.~~
2. ~~Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.~~
3. ~~Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing~~ **[with a drip edge]** ~~[with a sealant stop]~~ **[or flexible flashing with a metal drip edge]** ~~[or elastomeric thermoplastic flashing with a drip edge]~~ **[or flexible flashing with a metal sealant stop]**.
4. ~~Where flashing is fully concealed, use~~ **[metal flashing]** ~~[or]~~ **[flexible flashing]**.

C. ~~Solder and Sealants for Sheet Metal Flashings:~~ **[As specified in Section 076200 "Sheet Metal Flashing and Trim."]**

1. ~~Solder for Stainless Steel: ASTM B32, [Grade Sn60] [Grade Sn96], with acid flux of type recommended by stainless steel sheet manufacturer.~~
2. ~~Solder for Copper: ASTM B32, [Grade Sn50] [with maximum lead content of 0.2 percent].~~
3. ~~Elastomeric Sealant: ASTM C920, chemically curing [urethane] [polysulfide] [silicone] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.~~

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.~~

2.102.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from [neoprene] [urethane] [or] [PVC].
- B. Preformed Control-Joint Gaskets: Made from [styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805] [or] [PVC, complying with ASTM D2287, Type PVC-65406] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.112.7 MASONRY-CELL FILL

- A. Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
- B. Lightweight-Aggregate Fill: ASTM C331/C331M.

2.122.8 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] [masonry cement] [or] [mortar cement] mortar unless otherwise indicated.
 3. For exterior masonry, use [portland cement-lime] [masonry cement] [or] [mortar cement] mortar.
 4. For reinforced masonry, use [portland cement-lime] [masonry cement] [or] [mortar 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.
- C. Mortar for Unit Masonry: Comply with ASTM C270, [Proportion] [Property] Specification. Provide the following types of mortar for applications stated unless another type is indicated [or needed to provide required compressive strength of masonry].
 1. For masonry below grade or in contact with earth, use [Type M] [Type S].
 2. For reinforced masonry, use [Type S] [Type N].

3. For mortar parge coats, use **[Type S]** **[or]** **[Type N]**.
 4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Pigmented Mortar: Use colored cement product **[or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products]**.
1. Pigments does not exceed 10 percent of portland cement by weight.
 2. Pigments does not exceed 5 percent of **[masonry cement]** **[or]** **[mortar cement]** by weight.
 3. Mix to match Architect's sample.
 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
 - b. Pre-faced CMUs.
 - c. Cast-stone trim units.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Architect's sample.
 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
 - b. Pre-faced CMUs.
 - c. Cast-stone trim units.
- F. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C476, **[Table 1]** **[or]** **[paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi]**.
 3. Provide grout with a slump of **[8 to 11 inches]** **[10 to 11 inches]** as measured in accordance with ASTM C143/C143M.
- G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
1. Application: Use epoxy pointing mortar for exposed mortar joints with pre-faced CMUs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 2. Verify that foundations are within tolerances specified.

3. Verify that reinforcing dowels are properly placed.
 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch** or minus **1/4 inch**.
 2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch**.
 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch** in a story height or **1/2 inch** total.
- B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 feet**, or **1/2-inch** maximum.
 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 feet, 1/4 inch in 20 feet**, or **1/2-inch** maximum.
 3. For vertical lines and surfaces do not vary from plumb by more than **1/4 inch in 10 feet, 3/8 inch in 20 feet**, or **1/2-inch** maximum.
 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 feet, 1/4 inch in 20 feet**, or **1/2-inch** maximum.
 5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 feet, 3/8 inch in 20 feet**, or **1/2-inch** maximum.
 6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 feet**, or **1/2-inch** maximum.
 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch**.
- C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**, with a maximum thickness limited to **1/2 inch**.
 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch**.

3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch** or minus **1/4 inch**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in **[running bond]** **[bond pattern indicated on Drawings]**; do not use units with less-than-nominal **4-inch** horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than **[2 inches]** **[4 inches]**. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch** horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout **24 inches** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide **1/2-inch** clearance between end of anchor rod and end of tube. Space anchors **[48 inches]** **<Insert spacing>** o.c. unless otherwise indicated.
 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.

2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Wet joint surfaces thoroughly before applying mortar.
 3. Rake out mortar joints for pointing with sealant.
- D. Rake out mortar joints at pre-faced CMUs to a uniform depth of **1/4 inch** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-CELL FILL INSTALLATION

- A. Pour [~~loose-fill insulation~~] [**lightweight-aggregate fill**] into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than **20 feet**.
- B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 ~~MASONRY-JOINT REINFORCEMENT~~

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

3.83.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than **1 1/2 inch** **1 inch** **2 inches** wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than **24 inches** o.c. vertically and **36 inches** o.c. horizontally.

3.93.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry **[as follows]** **[using one of the following methods]**:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.103.9 LINTELS

- A. Provide **[concrete]** **[or]** **[masonry]** lintels where shown and where openings of more than **12 inches** for brick-size units and **24 inches** for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of **8 inches** at each jamb unless otherwise indicated.

3.113.10 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall 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, extend flashing a minimum of **6 inches** into masonry at each end. At heads and sills, extend flashing **6 inches** at ends and turn up not less than **2 inches** to form end dams.
 - 3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than **1-1/2 inches** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 4. Install metal **[drip edges]** **[and]** **[sealant stops]** with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for

- application indicated.
5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch** back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing **1/2 inch** back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.123.11 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other 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**] [**12.67 ft.**] <Insert height>.

3.133.12 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 is done at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level [B] [C] 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.** of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- G. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for [mortar air content] [and] [compressive strength].
- H. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.
- I. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at [7 days and at] 28 days.

3.143.13 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of **3/4 inch**. 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**. 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.

3.153.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.163.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than **4 inches** in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within **18 inches** of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. 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 042200

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.
- ~~3. Prefabricated building columns.~~
- ~~4-3.~~ Shear stud connectors.

~~B. Related Requirements:~~

- ~~1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.~~
- ~~2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.~~
- ~~3. Section 055000 "Metal Fabrications" for [steel lintels and shelf angles not attached to structural steel frame] [miscellaneous steel fabrications] and other steel items not defined as structural steel.~~
- ~~4. [Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"] [and] [Section 099600 "High-Performance Coatings"] for painting requirements.~~
- ~~5. Section 133419 "Metal Building Systems" for structural steel.~~

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
1. Shapes included in ASTM A6/A6M with flanges thicker than **1-1/2 inches**.
 2. Welded built-up members with plates thicker than **2 inches**.
 3. Column base plates thicker than **2 inches**.
- D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
- E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.5 ACTION SUBMITTALS

- A. Product Data:
 - 1. Structural-steel materials.
 - 2. High-strength, bolt-nut-washer assemblies.
 - 3. Shear stud connectors.
 - 4. Anchor rods.
 - 5. Threaded rods.
 - 6. Forged-steel hardware.
 - 7. Slide bearings.
 - 8. Prefabricated building columns.
 - 9. Shop primer.
 - 10. Galvanized-steel primer.
 - 11. Etching cleaner.
 - 12. Galvanized repair paint.
 - 13. Shrinkage-resistant grout.
- 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.
 - 3. Health Product Declaration: For each product.
 - 4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - 5. Environmental Product Declaration: For each product.
 - 6. Environmental Product Declaration: For each product.
 - 7. Environmental Product Declaration: For each product.
 - 8. Third-Party Certifications: For each product.
 - 9. Third-Party Certified Life Cycle Assessment: For each product.
 - 10. Health Product Declaration (HPD): For each product.
 - 11. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
- C. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment Drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 5. Identify members and connections of the seismic-load-resisting system.
 6. Indicate locations and dimensions of protected zones.
 7. Identify demand-critical welds.
 8. Identify members not to be shop primed.
- D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint [**whether prequalified or qualified by testing**] [**qualified by testing**], including the following:
1. Power source (constant current or constant voltage).
 2. Electrode manufacturer and trade name, for demand-critical welds.
- E. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data [**signed and sealed by the qualified professional engineer responsible for their preparation**].

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [**Installer**] [**fabricator**] [**shop-painting applicators**] [**professional engineer**] [**testing agency**].
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shear stud connectors.
 5. **<Insert product>**.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control reports.

1.7 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 (Acceptance Criteria 172).

- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, [Category ACSE] [Category CSE].
- C. Shop-Painting Applicator Qualifications: Qualified in accordance with AISC's Sophisticated Paint [Endorsement P1] [Endorsement P2] [Endorsement P3] or to SSPC-QP 3.
- D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
 - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. ANSI/AISC 341.
 - 3. ANSI/AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 - 1. Option 1: Connection designs have been completed and connections indicated on the Drawings.
 - 2. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.
 - a. Select and complete connections using [schematic details indicated] [and] [ANSI/AISC 360] <Insert source>.
 - b. Use [Load and Resistance Factor Design; data are given at factored-load level] [Allowable Stress Design; data are given at service-load level].

3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.
 - a. Use [Load and Resistance Factor Design; data are given at factored-load level] [Allowable Stress Design; data are given at service-load level].
4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.
 - a. Use [Load and Resistance Factor Design; data are given at factored-load level] [Allowable Stress Design; data are given at service-load level].
- C. Moment Connections: [Type PR, partially] [Type FR, fully] restrained.
- D. Construction: [Moment frame] [Braced frame] [Shear wall system] [Combined system of moment frame and braced frame] [Combined system of moment frame and shear walls] [Combined system of braced frame and shear walls] [Combined system of moment frame, braced frame, and shear walls].

2.2 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.
- B. W-Shapes: [ASTM A992/A992M] [ASTM A572/A572M, Grade 50] [ASTM A529/A529M, Grade 50] [ASTM A913/A913M, Grade 50].
- C. Channels, Angles, M-Shapes: [ASTM A36/A36M] [ASTM A572/A572M, Grade 50] [ASTM A529/A529M, Grade 50] [ASTM A913/A913M, Grade 50].
- D. Channels, Angles, S-Shapes: [ASTM A36/A36M] [ASTM A572/A572M, Grade 50] [ASTM A529/A529M, Grade 50] [ASTM A913/A913M, Grade 50].
- E. Plate and Bar: [ASTM A36/A36M] [ASTM A572/A572M, Grade 50] [ASTM A529/A529M, Grade 50].
- F. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi.
- G. Cold-Formed Hollow Structural Sections: [ASTM A500/A500M, Grade B] [ASTM A500/A500M, Grade C] [ASTM A1085/ASTMA1085M] structural tubing.
- H. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.
- I. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
 1. Weight Class: [Standard] [Extra strong] [Double-extra strong].
 2. Finish: [Black] [Galvanized] [Black except where indicated to be galvanized].
- J. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.
- K. Steel Forgings: ASTM A668/A668M.

- L. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
1. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1**, compressible-washer type with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A490**, Type 1, heavy-hex steel structural bolts[or **Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends**]; **ASTM A563, Grade DH**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
1. Direct-Tension Indicators: ASTM F959/F959M, **Type 490-1**, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325**, Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
1. Finish: [Hot-dip zinc coating] [Mechanically deposited zinc coating] [Hot-dip or mechanically deposited zinc coating].
2. Direct-Tension Indicators: ASTM F959/F959M, **Type 325-1**, compressible-washer type with [mechanically deposited zinc coating] [mechanically deposited zinc coating, baked epoxy-coated] finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, [heavy-hex] [round] head assemblies, consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
1. Finish: [Plain] [Mechanically deposited zinc coating].
- E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: [ASTM F1554, Grade 36] [ASTM F1554, Grade 55, weldable] [ASTM A354] [ASTM A449] [ASTM A572/A572M, **Grade 50**] [ASTM A36/A36M].
1. Configuration: [Straight] [Hooked].
2. Nuts: **ASTM A563** [heavy-] hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: **ASTM F436**, Type 1, hardened carbon steel.
5. Finish: [Plain] [Hot-dip zinc coating, ASTM A153/A153M, Class C] [Mechanically deposited zinc coating, ASTM B695, Class 50].
- B. Headed Anchor Rods: [ASTM F1554, Grade 36] [ASTM F1554, Grade 55, weldable] [ASTM A354] [ASTM A449], straight.
1. Nuts: **ASTM A563** [heavy-] hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.

3. Washers: **ASTM F436**, Type 1, hardened carbon steel.
4. Finish: **[Plain]** **[Hot-dip zinc coating, ASTM A153/A153M, Class C]** **[Mechanically deposited zinc coating, ASTM B695, Class 50]**.

- C. Threaded Rods: **[ASTM A36/A36M]** **[ASTM A193/A193M, Grade B7]** **[ASTM A354, Grade BD]** **[ASTM A449]** **[ASTM A572/A572M, Grade 50]**.

1. Nuts: **ASTM A63** **[heavy-]**hex carbon steel.
2. Washers: **[ASTM F436, Type 1, hardened]** **[ASTM A36/A36M]** carbon steel.
3. Finish: **[Plain]** **[Hot-dip zinc coating, ASTM A153/A153M, Class C]** **[Mechanically deposited zinc coating, ASTM B695, Class 50]**.

2.5 FORGED-STEEL STRUCTURAL HARDWARE

- A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.
- B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.
- C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 PRIMER

- A. Steel Primer:
1. Comply with **[Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."]** **[Section 099600 "High-Performance Coatings."]** **[Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."]**
 2. SSPC-Paint 23, latex primer.
 3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: **[MPI#26]** **[MPI#80,]** **[MPI#134]**.
1. Etching Cleaner: MPI#25, for galvanized steel.
 2. Galvanizing Repair Paint: **[MPI#18, MPI#19, or SSPC-Paint 20]** **[ASTM A780/A780M]**.

2.7 SHRINKAGE-RESISTANT GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.8 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, [**mechanically thermal cut**,] or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with [SSPC-SP 1.] [SSPC-SP 2.] [SSPC-SP 3.]
- F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than **10 inches** o.c. unless otherwise indicated on Drawings.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. [**Do not thermally cut bolt holes or enlarge holes by burning.**]
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.9 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: [**Snug tightened**] [**Pretensioned**] [**Slip critical**].
- B. Weld Connections: Comply with AWS D1.1/D1.1M[**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

~~2.10 — PREFABRICATED BUILDING COLUMNS~~

~~A. — Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.~~

~~1. — Fire-Resistance Design: UL Design No. <Insert designation>.~~

~~2. — Fire-Resistance Rating: [Four hours] [Three hours] [Two hours] [As indicated on Drawings].~~

~~2.12.10 GALVANIZING~~

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize [lintels] [shelf angles] [and] [welded door frames] attached to structural-steel frame and located in exterior walls.

~~2.12.11 SHOP PRIMING~~

- A. Shop prime steel surfaces, except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches**.
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces [unless indicated to be painted].
 6. Corrosion-resisting (weathering) steel surfaces.
 7. Surfaces enclosed in interior construction.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
1. SSPC-SP 2.
 2. SSPC-SP 3.
 3. SSPC-SP 7 (WAB)/NACE WAB-4.
 4. SSPC-SP 14 (WAB)/NACE WAB-8.
 5. SSPC-SP 11.
 6. SSPC-SP 6 (WAB)/NACE WAB-3.
 7. SSPC-SP 10 (WAB)/NACE WAB-2.
 8. SSPC-SP 5 (WAB)/NACE WAB-1.
 9. SSPC-SP 8.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner [or in accordance with SSPC-SP 16].

- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of **1.5 mils**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.132.12 SOURCE QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform shop tests and inspections.
1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 2. Bolted Connections: Inspect **[and test]** shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
 5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. **[Snug-tighten] [Pretension]** anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. **[Comply with manufacturer's written installation instructions for grouting.]**
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection **[unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M].**
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
 - 1. Joint Type: **[Snug tightened] [Pretensioned] [Slip critical]**.
- B. Weld Connections: Comply with AWS D1.1/D1.1M **[and AWS D1.8/D1.8M]** for tolerances, appearances, welding procedure

specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or runoff tabs[**where indicated**], back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.
- C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

~~3.5~~ ~~INSTALLATION OF PREFABRICATED BUILDING COLUMNS~~

- ~~A. ~~Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.~~~~

3.63.5 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Cleaning and touchup painting are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.73.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
1. Verify structural-steel materials and inspect steel frame joint details.
 2. Verify weld materials and inspect welds.
 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
1. Bolted Connections: Inspect[**and test**] bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

- a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 051200

SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Architecturally exposed structural steel (AESS).
 - 2. Section 051200 "Structural Steel Framing" requirements that also apply to AESS.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for [steel lintels and shelf angles not attached to structural-steel frame] [miscellaneous steel fabrications] [and] [other metal items] not defined as structural steel.
 - 2. [Section 099113 "Exterior Painting"] [Section 099123 "Interior Painting"] [and] [Section 099600 "High-Performance Coatings"] for surface preparation and priming requirements.

1.2 DEFINITIONS

- A. AESS: Architecturally exposed structural steel.
- B. Category AESS 1: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 1 and may be designated AESS 1 or Category AESS 1 in the Contract Documents.
- C. Category AESS 2: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 2 and is designated as AESS 2 or Category AESS 2 in the Contract Documents.
- D. Category AESS 3: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 3 and is designated as AESS 3 or Category AESS 3 in the Contract Documents.
- E. Category AESS 4: Structural steel that is categorized by ANSI/AISC 303, Section 10, as AESS 4 and is designated as AESS 4 or Category AESS 4 in the Contract Documents.
- F. Category AESS C: Structural steel with custom characteristics that is categorized by ANSI/AISC 303, Section 10, as AESS C and is designated as AESS C or Category AESS C in the Contract Documents.
- G. SEAC/RMSCA Guide Specification: SEAC/RMSCA's "Sample Specification, Section 05 02 13: Architecturally Exposed Structural Steel."

1.3 COORDINATION

- A. Coordinate surface preparation requirements for shop-primed items.
- B. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written

recommendations to ensure that shop primers and topcoats are compatible with one another.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.5 ACTION SUBMITTALS

- A. Product Data:

1. Tension-control, high-strength, bolt-nut-washer assemblies.
2. Corrosion-resisting (weathering steel), tension-control, high-strength, bolt-nut-washer assemblies.
3. Filler.
4. Primer.
5. Galvanized-steel primer.
6. Etching cleaner.
7. Galvanized repair paint.

- B. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Health Product Declaration (HPD): For each product.
10. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

- C. Shop Drawings: Show fabrication of AECS components. [**Shop Drawings for structural steel may be used for AECS.**]

1. Identify AECS category for each steel member and connection, including transitions between AECS categories and between AECS and non-AECS.
2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
3. Include embedment Drawings.
4. Indicate orientation of mill marks and HSS seams.
5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. [**Indicate grinding, finish, and profile of welds.**]
6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation and location of bolt heads.
7. Indicate exposed surfaces and edges and surface preparation being used.
8. Indicate special tolerances and erection requirements.
9. Indicate weep holes for HSS [**and vent holes for galvanized HSS**].
10. Indicate surface preparation, primer, and coating requirements, including systems specified in other Sections.

- D. Samples: Submit Samples to set quality standards for AESS.
1. Two steel plates, **3/8 by 8 by 4 inches**, with long edges joined by a groove weld[**and with weld ground smooth**].
 2. Steel plate, **3/8 by 8 by 8 inches**, with one end of a short length of rectangular steel tube, **4 by 6 by 3/8 inches**, welded to plate with a continuous fillet weld[**and with weld ground smooth and blended**].
 3. Round steel tube or pipe, minimum **8 inches** in diameter, with end of another round steel tube or pipe, approximately **4 inches** in diameter, welded to its side at a 45-degree angle with a continuous fillet weld[**and with weld ground smooth and blended**].

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [fabricator] [shop-painting applicator].
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.7 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] [Category CSE], 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] [Endorsement P2] [Endorsement P3] or SSPC-QP 3.
- D. Mockups: Build mockups of AESS to set quality standards for fabrication and installation.
1. Build mockup of typical portion of AESS as shown on Drawings.
 2. Coordinate painting requirements with [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."]
 3. Coordinate high-performance coatings requirements with Section 099600 "High-Performance Coatings."
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. 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.

1.9 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 ~~BOLTS, CONNECTORS, AND ANCHORS~~

- A. ~~Tension-Control, High-Strength, Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round-head assemblies consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.~~

1. ~~Finish: [Plain] [Mechanically deposited zinc coating].~~

- B. ~~Corrosion-Resisting (Weathering) Steel, Tension-Control, High-Strength, Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 3, round-head assemblies consisting of steel structural bolts with splined ends; **ASTM A563, Grade DH3**, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 3, hardened carbon-steel washers.~~

2.3 ~~FILLER~~

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

2.4 ~~PRIMER~~

- A. ~~Steel Primer:~~

1. ~~Comply with [Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."] [Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."]~~
2. ~~SSPC-Paint 23, latex primer.~~
3. ~~Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.~~

- B. ~~Galvanized Steel Primer: [MPI#26] [MPI#80] [MPI#134].~~

1. ~~Etching Cleaner: MPI#25, for galvanized steel.~~
2. ~~Galvanizing Repair Paint: [MPI#18, MPI#19, or SSPC-Paint 20] [ASTM A780/A780M].~~

2.5 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** closure plates.
6. Limit butt and plug weld projections to **1/16 inch**.
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.

C. Category AESS 2:

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** closure plates.
6. Limit butt and plug weld projections to **1/16 inch**.
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. Limit as-fabricated straightness tolerance to one-half that permitted for structural steel materials in ANSI/AISC 303.
13. Limit as-fabricated curved structural steel tolerance to that permitted for structural steel materials in ANSI/AISC 303.
14. Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. Conceal fabrication and erection markings from view in the completed structure.
16. Make welds uniform and smooth.

D. Category AESS 3:

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** closure plates.
6. — Limit butt and plug weld projections to **1/16 inch**.
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. — Limit as-fabricated straightness tolerance to one-half that permitted for structural steel materials in ANSI/AISC 303.
13. — Limit as-fabricated curved structural steel tolerance to that permitted for structural steel materials in ANSI/AISC 303.
14. — Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. — Conceal fabrication and erection markings from view in the completed structure.
16. — Make welds uniform and smooth.
17. — Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
18. — Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
19. — Orient HSS seams as indicated or away from view.
20. — Align and match abutting member cross sections.
21. — At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of **1/8 inch**. At closed joints, maintain uniform contact within **1/16 inch**.
22. — Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.

E. — Category AESS 4:

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** closure plates.
6. — Limit butt and plug weld projections to **1/16 inch**.
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. — Limit as-fabricated straightness tolerance to one-half that permitted for structural steel materials in ANSI/AISC 303.
13. — Limit as-fabricated curved structural steel tolerance to that permitted for structural steel materials in ANSI/AISC 303.
14. — Limit as-fabricated straightness tolerance of welded built-up members to one-half that permitted by AWS D1.1/D1.1M.
15. — Conceal fabrication and erection markings from view in the completed structure.
16. — Make welds uniform and smooth.
17. — Cut out mill marks from mill material or hide these markings from view in the completed structure. Where neither method is possible, remove mill marks by grinding and filling surfaces as approved by Architect.
18. — Grind butt and plug welds smooth or fill, removing weld splatter exposed to view.
19. — Orient HSS seams as indicated or away from view.
20. — Align and match abutting member cross sections.

21. — At visible open joints of copes, miters, and cuts, maintain uniform clear gaps of **1/8 inch**. At closed joints, maintain uniform contact within **1/16 inch**.
22. — Fabricate with exposed surfaces smooth, square, and of surface quality approved by Architect.
23. — Treat HSS seams to appear seamless.
24. — Contour and blend welds and weld transitions between members, removing splatter exposed to view.
25. — Fill surface imperfections with filler and sand smooth to achieve surface quality approved by Architect.
26. — Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.

- F. — Erection marks, painted marks, and other marks are permitted on ~~[galvanized]~~ **[corrosion-resisting (weathering)]** steel surfaces of completed structure.
- G. — Cleaning Corrosion-Resisting (Weathering) AESS: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6 (WAB)/NACE WAB-3.

2.6 — SHOP CONNECTIONS

- A. — High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
1. — Joint Type: ~~[Snug tightened]~~ **[Protensioned]** ~~[Slip critical]~~.
- B. — Weld Connections: Comply with AWS D1.1/D1.1M **[and AWS D1.8/D1.8M]** for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 — GALVANIZING

- A. — Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
1. — Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 2. — Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
 3. — Galvanize AESS ~~[lintels]~~ **<Insert description>** attached to structural-steel frame and located in exterior walls.

2.8 — SHOP PRIMING

- A. — Shop prime steel surfaces, except the following:
1. — Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of **2 inches**.
 2. — Surfaces to be field welded.
 3. — Surfaces to be high-strength bolted with slip-critical connections.
 4. — Corrosion-resisting (weathering) steel surfaces.
 5. — Galvanized surfaces ~~[unless indicated to be painted]~~.
- B. — Surface Preparation: Clean nongalvanized 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.~~
2. ~~SSPC-SP 3.~~
3. ~~SSPC-SP 7 (WAB)/NACE WAB-4.~~
4. ~~SSPC-SP 14 (WAB)/NACE WAB-8.~~
5. ~~SSPC-SP 11.~~
6. ~~SSPC-SP 6 (WAB)/NACE WAB-3.~~
7. ~~SSPC-SP 10 (WAB)/NACE WAB-2.~~
8. ~~SSPC-SP 5 (WAB)/NACE WAB-1.~~
9. ~~SSPC-SP 8.~~

C. ~~Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner [or according to SSPC-SP 16].~~

D. ~~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. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.~~

1. ~~Stripe paint corners, crevices, bolts, welds, and eased edges.~~
2. ~~Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.~~

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.
 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments, showing dimensions, locations, angles, and elevations.
- B. Examine AECS 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 AECS 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 AECS and to minimize damage to shop painting. Set AECS 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. Remove erection bolts in [Category AESS 4] <Insert category> AESS, fill holes with weld metal or filler, and grind or sand smooth to achieve surface quality approved by Architect.
 6. Fill weld access holes in [Category AESS 4] <Insert category> AESS with weld metal or filler and grind, or sand smooth to achieve surface quality as approved by Architect.
 7. Conceal fabrication and erection markings from view in the completed structure.
- B. In addition to ANSI/AISC 303, Section 10 requirements, comply with the following.
1. Erection of [Category AESS 1] [and Category AESS 2]:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than **1/16 inch**.
 - e. Continuous welds are to be of uniform size and profile.
 - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
 - g. Splice members only where indicated on Drawings.
 - h. No torch cutting or field fabrication is permitted.
 2. Erection of Category AESS 3:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than **1/16 inch**.
 - e. Continuous welds are to be of uniform size and profile.
 - f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
 - g. Splice members only where indicated on Drawings.
 - h. No torch cutting or field fabrication is permitted.
 - i. Weld profiles, quality, and finish are to be as approved by Architect.
 - j. Make joint welds, including tack welds, appear continuous by filling intermittent welds.
 3. Erection of Category AESS 4:
 - a. Erect AESS to the standard frame tolerances specified in ANSI/AISC 303 for non-AESS.
 - b. Comply with AWS D1.1/D1.1M. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - c. Remove weld spatter, slivers, and similar surface discontinuities.
 - d. Grind off butt and plug weld projections larger than **1/16 inch**.

- e. Continuous welds are to be of uniform size and profile.
- f. Ream holes that must be enlarged. Use of drift pins or burning is not permitted. Replace misaligned connection plates where holes cannot be aligned with acceptable appearance.
- g. Splice members only where indicated on Drawings.
- h. No torch cutting or field fabrication is permitted.
- i. Weld profiles, quality, and finish are to be as approved by Architect.
- j. Make joint welds, including tack welds, appear continuous by filling intermittent welds.
- k. Grind welds smooth.
- l. Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.
- m. Oversize welds where ground, contoured, or blended, and grind to provide a smooth transition, matching profile approved by Architect.

4. Erection of Category AESS C:

- a. <Insert requirements>.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: [Snug tightened] [Pretensioned] [Slip critical].
- B. Weld Connections: Comply with AWS D1.1/D1.1M [and AWS D1.8/D1.8M] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

3.5 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and touchup galvanizing to comply with ASTM A780/A780M.
- B. 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 as used for shop painting, to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Cleaning and touchup painting are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to inspect AESS as specified in Section 051200 "Structural

Steel Framing." The testing agency is not responsible for enforcing requirements relating to aesthetic effect.

- B. Architect will observe AEES in place to determine acceptability relating to aesthetic effect.

END OF SECTION 051213

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Roof deck.~~
- ~~2. Acoustical roof deck.~~
- ~~3. Composite floor deck.~~
- ~~4. Electrified cellular floor deck.~~
- ~~5. Noncomposite form deck.~~
- ~~6. Noncomposite vented form deck.~~

B. Related Requirements:

- ~~1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.~~
- ~~2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.~~
- ~~3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.~~
- ~~4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Acoustical roof deck.
3. Composite floor deck.
4. Electrified cellular floor deck.
5. Noncomposite form deck.
6. Noncomposite vented form deck.

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.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Health Product Declaration (HPD): For each product.
12. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Test and Evaluation Reports:
 1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - a. Power-actuated mechanical fasteners.
 - b. Acoustical roof deck.
 2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.
- D. Field Quality-Control Submittals:
 1. Field quality-control reports.
- E. Qualification Statements: For **[welding personnel]** **[and]** **[testing agency]**.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:
 1. AWS D1.1/D1.1M.
 2. AWS D1.3/D1.3M.
- B. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.
- C. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and **[Class 1-60]** **[Class 1-75]** **[Class 1-90]** windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] ~~<Insert value>~~ percent.

2.2 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10** minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi**, not less than **0.0359-inch** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi**, of same material and finish as deck, and of thickness and profile [indicated] [recommended by SDI standards for overhang and slab depth].
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [**0.0598 inch**] [**0.0747 inch**] thick, with factory-punched hole of **3/8-inch** minimum diameter.

- J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- K. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch** thick, of same material and finish as deck. For drains, cut holes in the field.
- L. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch** thick, of same material and finish as deck, with **3-inch** wide flanges and ~~[level]~~ **[sloped]** recessed pans of **1-1/2-inch** minimum depth. For drains, cut holes in the field.
- M. Galvanizing Repair Paint: **[ASTM A780/A780M] [SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight]**.
- N. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck

manufacturer's written instructions.

- J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 ~~INSTALLATION OF ROOF DECK~~

- A. ~~Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:~~
- ~~1. Weld Diameter: [5/8 inch] [3/4 inch], nominal.~~
 - ~~2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds [18 inches apart, maximum] [12 inches apart in Zone 1 and 6 inches apart in Zones 2 and 3, based on roof-area definitions in FM Global Loss Prevention Data Sheet 1-28] [as indicated].~~
 - ~~3. Weld Washers: Install weld washers at each weld location.~~
- B. ~~Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or [18 inches] [36 inches], and as follows:~~
- ~~1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.~~
 - ~~2. Mechanically clinch or button punch.~~
 - ~~3. Fasten with a minimum of 1-1/2-inch long welds.~~
- C. ~~End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:~~
- ~~1. End Joints: [Lapped 2 inches minimum] [Butted] [Lapped 2 inches minimum or butted at Contractor's option].~~
- D. ~~Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and [weld] [mechanically fasten] flanges to top of deck. Space [welds] [mechanical fasteners] not more than 12 inches apart with at least one [weld] [fastener] at each corner.~~
- ~~1. Install reinforcing channels or zees in ribs to span between supports and [weld] [or] [mechanically fasten].~~
- E. ~~Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with 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.~~
- F. ~~Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.~~
- G. ~~Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in <Insert Section number and title>.~~

3.43.3 ~~INSTALLATION OF FLOOR DECK~~

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
1. Weld Diameter: [5/8 inch] [3/4 inch], nominal.
 2. Weld Spacing:

- a. Weld edge ribs of panels at each support. Space additional welds an average of **16 inches** apart, but not more than **18 inches** apart.
 - b. Space and locate welds as indicated.
3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches**, and as follows:
 1. Mechanically fasten with self-drilling, **No. 10** diameter or larger, carbon-steel screws.
 2. Mechanically clinch or button punch.
 3. Fasten with a minimum of **1-1/2-inch** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **[1-1/2 inches]** **<Insert dimension>**, with end joints as follows:
 1. End Joints: **[Lapped]** **[Butted]** **[Lapped or butted at Contractor's option]**.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- F. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from **[all-cellular units]** **[alternating cellular units with noncellular composite units]** **[units indicated]**.
 1. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components specified in Section 260539 "Underfloor Raceways for Electrical Systems" with installation of electrified cellular metal floor deck.
- G. Install piercing hanger tabs at **[14 inches]** **<Insert dimension>** apart in both directions, within **9 inches** of walls at ends, and not more than **12 inches** from walls at sides unless otherwise indicated.

3.53.4 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 1. Wire brush and clean rust spots, welds, and abraded areas on **[both surfaces]** **[top surface]** of prime-painted deck immediately after installation, and apply repair paint.
 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.63.5 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.
 - a. Field welds will be subject to inspection.
 - 2. Steel decking will be considered defective if it does not pass tests and inspections.
 - 3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.
- C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
- ~~2. Prefabricated building columns.~~
- ~~3.2. Shelf angles.~~
- ~~4. Metal ladders.~~
- ~~5. Alternating tread devices.~~
- ~~6.3. Metal ships' ladders and pipe crossovers.~~
- ~~7.4. Metal floor plate.~~
- ~~8.5. Elevator pit sump covers.~~
- ~~9.6. Structural-steel door frames.~~
- ~~10.7. Miscellaneous steel trim.~~
- ~~11.8. Metal bollards.~~
- ~~12.9. Vehicular barrier cable systems.~~
- ~~13.10. Pipe and downspout guards.~~
- ~~14. Abrasive metal nosings, treads, and thresholds.~~
- ~~15.11. Cast-iron wheel guards.~~
- ~~16. Metal downspout boots.~~
- ~~17.12. Loose bearing and leveling plates.~~

~~B. Products furnished, but not installed, under this Section include the following:~~

- ~~1. Loose steel lintels.~~
- ~~2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.~~
- ~~3. Anchor bolts, steel pipe sleeves, slotted channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.~~

~~C. B.~~ Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and

directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Prefabricated building columns.
6. Slotted channel framing.
7. Manufactured metal ladders.
8. Alternating tread devices.
9. Metal ships' ladders and pipe crossovers.
10. Metal bollards.
11. Vehicular barrier cable systems.
12. Pipe and downspout guards.
13. Abrasive metal nosings, treads, and thresholds.
14. Cast-iron wheel guards.
15. Metal downspout boots.

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.**] Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Elevator machine beams, hoist beams, and divider beams.
3. Steel shapes for supporting elevator door sills.
4. Steel girders for supporting wood frame construction.
5. Steel pipe columns for supporting wood frame construction.
6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Alternating tread devices.
10. Metal ships' ladders and pipe crossovers.
11. Metal floor plate and supports.
12. Elevator pit sump covers.
13. Structural-steel door frames.
14. Miscellaneous steel trim including [steel angle corner guards] [steel edgings] [and] [loading-dock edge angles].
15. Metal bollards.
16. Loose steel lintels.
17. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded [nosing] [and] [tread].

D. Delegated Design Submittals: For [ladders] [alternating tread devices] [and] [vehicular barrier cable systems], including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental product declaration.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
4. Environmental Product Declaration (EPD): For each product.
5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
6. Environmental Product Declaration: For each product.
7. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
8. Environmental Product Declaration: For each product.
9. Environmental Product Declaration: For each product.
10. Third-Party Certifications: For each product.
11. Third-Party Certified Life Cycle Assessment: For each product.
12. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
13. Health Product Declaration (HPD): For each product.
14. Health Product Declaration (HPD): Provide HPD.
15. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Research Reports: For post-installed anchors.
- E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 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."

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [ladders] [alternating tread devices] [and] [vehicular barrier cable systems].
- B. Structural Performance of Aluminum Ladders: Ladders[, including landings,] are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.
- C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Comply with applicable railing loadings in Section 055213 "Pipe and Tube Railings."
- D. Vehicular Barrier Cable Systems: Design vehicular barrier cable systems to resist a single [6000-lbf] <Insert value> service load and [10,000-lbf] <Insert load> ultimate load applied horizontally in any direction to the cable system, with anchorages or attachments capable of transferring this load to the structure. Limit deflection to 18 inches. Design is to assume loads are applied at a height of [18 inches] <Insert height> above the floor or ramp surface on an area not to exceed 1 sq. ft..
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: [120 deg F, ambient; 180 deg F, material surfaces] <Insert temperature change>.

2.2 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. ~~Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.~~
- C. ~~Regional Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.~~
- D. ~~Regional Materials: Products shall be manufactured within 500 miles of Project site.~~
- E. ~~Regional Materials: Products shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.~~
- F. ~~Indigenous Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.~~

- G. — ~~Regional Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.~~
- H. — ~~Steel Plates, Shapes, and Bars: ASTM A36/A36M.~~
- I. — ~~Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, **[Type 304]** **[Type 316L]**.~~
- J. — ~~Stainless Steel Bars and Shapes: ASTM A276/A276M, **[Type 304]** **[Type 316L]**.~~
- K. — ~~Rolled Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.~~
- L. — ~~Rolled Stainless Steel Floor Plate: ASTM A793.~~
- M. — ~~Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.~~
- N. — ~~Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.~~
- O. — ~~Zinc-Coated Steel Wire Rope: ASTM A741.~~
1. — ~~Wire Rope Fittings: Hot-dip galvanized steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.~~
- P. — ~~Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.~~
1. — ~~Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.~~
- Q. — ~~Steel Prestressing Strand: ASTM A416/A416M, **Grade 270**, low-relaxation, seven-wire, with **0.9 lb/sq. ft.** zinc coating.~~
1. — ~~Steel Prestressing Strand Fittings: Hot-dip galvanized steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.~~
- R. — ~~Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.~~
1. — ~~Size of Channels: **[1-5/8 by 1-5/8 inches]** **[As indicated]** ~~<Insert size>~~.~~
2. — ~~Galvanized Steel: ASTM A653/A653M, **[commercial steel, Type B]** **[structural steel, Grade 33]**, with **G90** coating; **[0.108-inch]** **[0.079-inch]** **[0.064-inch]** nominal thickness.~~
3. — ~~Cold-Rolled Steel: ASTM A1008/A1008M, **[commercial steel, Type B]** **[structural steel, Grade 33]**; **[0.0966-inch]** **[0.0677-inch]** **[0.0528-inch]** minimum thickness; **[unfinished]** **[coated with rust-inhibitive, baked-on, acrylic enamel]** **[hot-dip galvanized after fabrication]**.~~
- S. — ~~Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.~~
- T. — ~~Aluminum Plate and Sheet: **ASTM B209**, Alloy 6061-T6.~~
- U. — ~~Aluminum Extrusions: **ASTM B221**, Alloy 6063-T6.~~
- V. — ~~Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.~~

- ~~W. — Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.~~
- ~~X. — Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).~~
- ~~Y. — Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).~~
- ~~Z. — Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.~~
- ~~AA. — Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).~~

2.32.2 FASTENERS

- A. General: Unless otherwise indicated, provide [Type 304] [Type 316] 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].
 2. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A**; with hex nuts, **ASTM A563**; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3**, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, **ASTM F593**; with hex nuts, **ASTM F594**; and, where indicated, flat washers; Alloy [Group 1] [Group 2].
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563**; and, where indicated, flat washers.
1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- H. Post-Installed Anchors: [Torque-controlled expansion anchors] [or] [chemical 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] [Group 2] stainless steel bolts, **ASTM F593**, and nuts, **ASTM F594**.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches** by length indicated with anchor straps or studs not less than **3 inches** long at not more than **8 inches** o.c. Provide with temporary filler

and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.42.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."] [Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."]
- 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 that contains 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 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of **3000 psi**.

2.52.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form 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. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches**, with a minimum **6-inch** embedment and **2-inch** hook, not less than **8 inches** from ends and corners of units and **24 inches** o.c., unless otherwise indicated.

2.62.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Fabricate supports for operable partitions from continuous steel beams of sizes [indicated] [recommended by partition manufacturer] with attached bearing plates, anchors, and braces as [indicated] [recommended by partition manufacturer]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
1. Provide bearing plates welded to beams where indicated.
 2. Drill or punch girders and plates for field-bolted connections where indicated.
 3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at **24 inches** o.c.
- E. 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.
1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
 2. Unless otherwise indicated, provide **1/2-inch** baseplates with four **5/8-inch** anchor bolts and **1/4-inch** top plates.
- F. Galvanize miscellaneous framing and supports where indicated.

- G. Prime miscellaneous framing and supports with [zinc-rich primer] [primer specified in Section 099600 "High-Performance Coatings"] where indicated.

2.72.6 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** bolts, spaced not more than **6 inches** from ends and **24 inches** o.c., unless otherwise indicated.
1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches** larger than expansion or control joint.
- B. 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.] [primer specified in Section 099600 "High-Performance Coatings."]
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3[, except for elevator pit ladders].
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails [16 inches] [18 inches] apart unless otherwise indicated.
2. Siderails: Continuous, [3/8 by 2-1/2 inch] [1/2 by 2-1/2 inch] steel flat bars, with eased edges.
3. Rungs: [3/4 inch diameter] [3/4 inch square] [1 inch diameter] [1 inch square], steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than [1/2 inch] [3/4 inch] in least dimension.
8. Support each ladder[at top and bottom and not more than 60 inches o.c.] with welded or bolted steel brackets.
9. Galvanize[and prime] [exterior] ladders, including brackets.
10. Prime [exterior] ladders, including brackets and fasteners, with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.9 ALTERNATING TREAD DEVICES

- A. Galvanize[and prime] [exterior] steel alternating tread devices, including treads, railings, brackets, and fasteners.

- B. Prime ~~[exterior]~~ steel alternating tread devices, including treads, railings, brackets, and fasteners, with ~~[zinc-rich primer.]~~ [primer specified in Section 099600 "High-Performance Coatings."]

2.102.7 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Provide metal [ships' ladders] [and] [pipe crossovers] where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
1. Treads are not to be less than **5 inches** exclusive of nosing or less than **8-1/2 inches** including the nosing, and riser height is not to be more than **9-1/2 inches**.
 2. Fabricate [ships' ladders] [and] [pipe crossovers], including railings from [steel] [stainless steel] [aluminum].
 3. Fabricate treads[and platforms] from [welded or pressure-locked steel bar] [pressure-locked stainless steel bar] [pressure-locked aluminum bar] [extruded-aluminum plank] grating. Limit openings in gratings to no more than **[1/2 inch]** **[3/4 inch]** in least dimension.
 4. Fabricate treads[and platforms] from [rolled-steel floor] [rolled-stainless steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor] plate.
 5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."
- B. Galvanize[and prime] [exterior] steel [ships' ladders] [and] [pipe crossovers], including treads, railings, brackets, and fasteners.
- C. Prime [exterior] steel [ships' ladders] [and] [pipe crossovers], including treads, railings, brackets, and fasteners, with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.112.8 METAL FLOOR PLATE

- A. Fabricate from [rolled-steel floor] [rolled-stainless steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor] plate of thickness indicated below:
1. Thickness: **[1/8 inch]** **[3/16 inch]** **[1/4 inch]** **[5/16 inch]** **[3/8 inch]** [As indicated].
- B. Provide grating sections where indicated, fabricated from [welded or pressure-locked steel bar] [pressure-locked stainless steel bar] [pressure-locked aluminum bar] [extruded-aluminum plank] grating. Limit openings in gratings to no more than **[1/2 inch]** **[3/4 inch]** **[1 inch]** in least dimension.
- C. Provide [steel] [stainless steel] [aluminum] angle supports as indicated.
- D. Include [steel] [stainless steel] [aluminum] angle stiffeners, and fixed and removable sections as indicated.
- E. Provide flush [steel] [stainless steel] [aluminum] bar drop handles for lifting removable sections, one at each end of each section.

2.122.9 ELEVATOR PIT SUMP COVERS

- A. Fabricate from **[1/8-inch]** **[3/16-inch]** [rolled-steel] [abrasive-surface] floor plate with four **1-inch-** diameter holes for water drainage and for lifting.
- B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than **[1/2 inch]** **[3/4 inch]** **[1 inch]** in least dimension.

- C. Provide steel angle supports unless otherwise indicated.

2.132.10 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
- C. Galvanize[**and prime**] [**exterior**] steel frames.
- D. Prime [**exterior**] steel frames with [**zinc-rich primer.**] [**primer specified in Section 099600 "High-Performance Coatings."**]

2.142.11 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[**and prime**] [**exterior**] miscellaneous steel trim.
- D. Prime [**exterior**] miscellaneous steel trim with [**zinc-rich primer.**] [**primer specified in Section 099600 "High-Performance Coatings."**]

2.152.12 METAL BOLLARDS

- A. Fabricate metal bollards from [**Schedule 80 steel pipe**] [**Schedule 40 steel pipe**] [**Schedule 80 stainless steel, No. 4/180-grit finish**] [**1/4-inch wall-thickness rectangular steel tubing**] [**steel shapes, as indicated**].
1. Cap bollards with **1/4-inch**-thick, [**steel**] [**stainless steel, ASTM A480/A480M, No. 4 finish**] plate with [**flat**] [**sloped**] [**domed**] top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Fabricate bollards with **3/8-inch**-thick, [**steel**] [**stainless steel, ASTM A480/A480M, No. 4 finish**] baseplates for bolting to concrete slab. Drill baseplates at all four corners for **3/4-inch** anchor bolts.
1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
- C. Fabricate sleeves for bollard anchorage from steel or stainless steel [**pipe**] [**or**] [**tubing**] with **1/4-inch**-thick, steel or stainless steel

plate welded to bottom of sleeve. Make sleeves not less than **8 inches** deep and **3/4 inch** larger than OD of bollard.

- D. Fabricate internal sleeves for removable bollards from Schedule 80 **[steel]** **[stainless steel]** pipe or **1/4-inch** wall-thickness **[steel]** **[stainless steel]** tubing with an OD approximately **1/16 inch** less than ID of bollards. Match drill sleeve and bollard for **3/4-inch** **[steel]** **[stainless steel]** machine bolt.
- E. Prime steel bollards with **[zinc-rich primer.]** **[primer specified in Section 099600 "High-Performance Coatings."]**

2.162.13 VEHICULAR BARRIER CABLE SYSTEMS

- A. Vehicular Barrier Cable Systems: Of diameter required by performance requirements, but not less than **1/2-inch** diameter, **[zinc-coated steel wire rope]** **[stainless steel wire rope]** **[zinc-coated steel prestressing strand]** with turnbuckles, toggles, machine swage terminals, and other fittings and accessories for securing to structural columns and walls and for tightening barrier cable.

2.172.14 PIPE AND DOWNSPOUT GUARDS

- A. Fabricate **[pipe]** **[downspout]** guards from **3/8-inch** thick by **12-inch** wide, **[steel]** **[stainless steel, ASTM A480/A480M, No. 4 finish]** plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch** clearance between pipe and pipe guard. Drill each end for two **3/4-inch** anchor bolts.
- B. Galvanize **[and prime]** steel **[pipe]** **[downspout]** guards.
- C. Prime steel **[pipe]** **[downspout]** guards with **[zinc-rich primer.]** **[primer specified in Section 099600 "High-Performance Coatings."]**

~~2.18 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS~~

- ~~A. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.~~
- ~~B. Drill for mechanical anchors and countersink. Locate holes not more than **4 inches** from ends and not more than **12 inches** o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.~~
 - ~~1. Provide two rows of holes for units more than **5 inches** wide, with two holes aligned at ends and intermediate holes staggered.~~
- ~~C. Apply bituminous paint to concealed surfaces of cast-metal units.~~
- ~~D. Apply clear lacquer to concealed surfaces of extruded units.~~

2.192.15 CAST-IRON WHEEL GUARDS

- A. Provide wheel guards made from cast-iron, **3/4-inch** thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.
- B. Prime cast-iron wheel guards with **[zinc-rich primer.]** **[primer specified in Section 099600 "High-Performance Coatings."]**

2.202.16 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.212.17 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. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches** unless otherwise indicated.
- C. Galvanize[**and prime**] loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.222.18 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.

2.232.19 GENERAL FINISH REQUIREMENTS

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

2.242.20 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. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items[**not indicated to be galvanized**] unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with [universal shop primer] [primers specified in Section 099113 "Exterior Painting"] [primers specified in Section 099123 "Interior Painting"] unless [zinc-rich primer is] [primers specified in Section 099600 "High-Performance Coatings" are] indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."] [SSPC-SP 3, "Power Tool Cleaning."] [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 099600 "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."
- E. 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.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.252.21 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

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.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for **[ceiling-hung toilet partitions]** **[operable partitions]** **[overhead doors]** **[and]** **[overhead grilles]** securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with **[expansion anchors]** **[anchor bolts]** **[through bolts]**.
- D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- E. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

~~3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS~~

- ~~A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.~~

3.4.3 INSTALLATION OF SHELF ANGLES

- A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

~~3.5 INSTALLATION OF METAL LADDERS~~

- ~~A. Secure ladders to adjacent construction with the clip angles attached to the stringer.~~
- ~~B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.~~

~~3.6~~ INSTALLATION OF ALTERNATING TREAD DEVICES

- ~~A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.~~

~~3.73.4~~ INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.
- B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

~~3.83.5~~ INSTALLATION OF METAL FLOOR PLATE

- A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

~~3.93.6~~ INSTALLATION OF ELEVATOR PIT SUMP COVERS

- A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

~~3.103.7~~ INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

- A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

~~3.113.8~~ INSTALLATION OF MISCELLANEOUS STEEL TRIM

- A. Anchor to concrete construction to comply with manufacturer's written instructions.

~~3.123.9~~ INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
1. Do not fill removable bollards with concrete.
- B. Anchor bollards to existing construction with [expansion anchors] [anchor bolts] [through bolts]. Provide four **3/4-inch** bolts at each bollard unless otherwise indicated.
1. Embed anchor bolts at least **4 inches** in concrete.
- C. Anchor bollards in concrete [with pipe sleeves preset and anchored into concrete] [in formed or core-drilled holes not less than **42 inches deep and 3/4 inch larger than OD of bollard**]. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch** toward bollard.
- D. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches** above bottom of excavation. Place concrete

and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

- E. Anchor internal sleeves for removable bollards in [concrete by inserting in pipe sleeves preset into concrete] [formed or core-drilled holes not less than **42 inches** deep and **3/4 inch** larger than OD of sleeve]. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch** toward internal sleeve.
- F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- G. Place removable bollards over internal sleeves and secure with **3/4-inch** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.
- H. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.133.10 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

- A. Install vehicular barrier cable systems at locations indicated, mounted at heights indicated on Drawings above the parking surface. Anchor [wire ropes] [steel prestressing strand] to structural columns and walls and tension to withstand vehicle loading as specified in "Performance Requirements" Article with no cable tensioned less than **3000 lbf**. Do not displace supporting components.

3.143.11 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

- A. Provide pipe guards at exposed vertical pipes in [parking garage] [at locations indicated on Drawings] where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four **3/4-inch** bolts at each pipe guard. Mount pipe guards with top edge **26 inches** above driving surface.

~~3.15 — INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS~~

- ~~A. — Center nosings on tread widths unless otherwise indicated.~~
- ~~B. — For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.~~
- ~~C. — Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.~~

3.163.12 INSTALLATION OF CAST-IRON WHEEL GUARDS

- A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

~~3.17~~ ~~INSTALLATION OF METAL DOWNSPOUT BOOTS~~

- ~~A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.~~
- ~~B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.~~

~~3.18~~ ~~3.13~~ INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

~~3.19~~ ~~3.14~~ 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.
 - a. Apply by brush or spray to provide a minimum **2.0-mil** dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."]
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Steel railings.~~
- ~~2. Aluminum railings.~~
- ~~3. Stainless steel railings.~~

~~B. Related Requirements:~~

- ~~1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.~~
- ~~2. Section 057300 "Decorative Metal Railings" for ornamental railings fabricated from pipes and tubes and guard-infill metals.~~
- ~~3. Section 096900 "Access Flooring" for railings included with access flooring.~~

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of mechanically connected railings.
2. Expanded metal infill panels.
3. Perforated metal infill panels.
4. Woven-wire mesh infill panels.
5. Fasteners.
6. Post-installed anchors.
7. Handrail brackets.
8. Shop primer.
9. Intermediate coats and topcoats.
10. Bituminous paint.
11. Nonshrink, nonmetallic grout.
12. Anchoring cement.
13. Metal finishes.
14. 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 Initial Selection: For products involving selection of color, texture, or design[, **including mechanical finishes**].
- E. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of [**connecting**] [**and**] [**finishing**] members at intersections.
- F. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [**delegated design professional engineer**] [**testing agency**].
- B. Welding certificates.
- C. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- F. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 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."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of **50 lbf/ft.** applied in any direction.
 - b. Concentrated load of **200 lbf** applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of **50 lbf** applied horizontally on an area of **1 sq. ft.**
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: [**120 deg F, ambient; 180 deg F, material surfaces**] <Insert temperature change>.

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 [**flange tapped for concealed anchorage to threaded hanger bolt**] [**predrilled hole for exposed bolt anchorage**] and that provides **1-1/2-inch** clearance from inside face of handrail to finished wall surface.

2.3 FASTENERS

- A. Fastener Materials:
 - 1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941/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.
 - 3. Aluminum Railing Components: [Type 304] [Type 316] stainless steel fasteners.
 - 4. Stainless Steel Railing Components: [Type 304] [Type 316] stainless steel fasteners.
 - 5. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction[**and capable of withstanding design loads**].
- C. Fasteners for Interconnecting Railing Components:
- 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide [Phillips] [tamper-resistant] [square or hex socket] flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. 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] [Group 2] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: [Cast iron] [Cast aluminum,] [Cast stainless steel,] [Cast nickel-silver,] center of handrail [2-1/2 inches] [3-1/8 inches] <Insert dimension> from [face of railing] [wall].
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
- 1. For [aluminum] [and] [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 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
- 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 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
- 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] [and] [where indicated on Drawings], 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.

2.5 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[, **but not less than that required to support structural loads**].
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately **1/32 inch** unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

- G. Connections: Fabricate railings with **[welded]** **[or]** **[nonwelded]** connections unless otherwise indicated.
- H. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with **[cam-type, self-closing]** **[spring]** hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.
- I. 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 #1 welds; ornamental quality with no evidence of a welded joint]** **[Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay]** **[Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed]**.
- J. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- K. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.
- L. Form changes in direction as follows:
 - 1. As detailed.
 - 2. **[By bending]** **[or]** **[by inserting prefabricated elbow fittings]**.
 - 3. **[By flush bends]** **[or]** **[by inserting prefabricated flush-elbow fittings]**.
 - 4. **[By radius bends of radius indicated]** **[or]** **[by inserting prefabricated elbow fittings of radius indicated]**.
 - 5. By bending to smallest radius that will not result in distortion of railing member.
- M. 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.
- N. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- O. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is **1/4 inch** or less.
- P. 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.
- Q. 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.
- R. For railing posts set in concrete, provide stainless steel sleeves not less than **6 inches** long with inside dimensions not less than **1/2 inch** greater than outside dimensions of post, with metal plate forming bottom closure.
- S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
1. Provide socket covers designed and fabricated to resist being dislodged.
 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- T. Expanded-Metal Infill Panels: Fabricate infill panels from expanded-metal sheet of same metal as railings.
1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than **0.043 inch** thick.
 2. Orient expanded metal with long dimension of diamonds [parallel to top rail] [perpendicular to top rail] [horizontal] [vertical].
- U. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from [steel] [galvanized steel] [aluminum] [stainless steel] [same metal as railings in which they are installed].
1. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than **0.043 inch** thick.
 2. Orient perforated metal with pattern [parallel to top rail] [perpendicular to top rail] [horizontal] [vertical] [as indicated on Drawings].
- V. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into **1-by-1/2-by-1/8-inch** metal channel frames.
1. Fabricate wire mesh and frames from same metal as railings in which they are installed.
 2. Orient wire mesh with [diamonds vertical] [diamonds perpendicular to top rail] [wires perpendicular and parallel to top rail] [wires horizontal and vertical] [as indicated on Drawings].
- W. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.6 STEEL AND IRON FINISHES

- A. Galvanized Railings:
1. Hot-dip galvanize [exterior] [indicated] 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.
 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner[**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 **[SSPC-SP 6/NACE No. 3.] [SSPC-SP 3.] [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 099600 "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] [primers specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"]** unless **[zinc-rich primer is] [primers specified in Section 099600 "High-Performance Coatings" are]** indicated.
 - 2. Do not apply primer to galvanized surfaces.
- G. Shop-Painted Finish: Comply with **[Section 099113 "Exterior Painting."] [Section 099600 "High-Performance Coatings."]**
 - 1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]**.
- H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.
 - 1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range]**.

2.7 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are 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.
- B. Mill Finish: AA-M12, nonspecular as fabricated.
- C. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41] [AA-M12C22A31]**.
- D. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44] [AA-M12C22A32/A34]**.

1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].
- E. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- F. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with [AAMA 2604] [AAMA 2605] and containing not less than [50] [70] percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- G. Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- I. Single-Coat Superior Performance FEVE Organic Finish: Single-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish, complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- J. Two-Coat Superior Performance FEVE Organic Finish: Two-coat fluoroethylene vinyl ether (FEVE) fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.8 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 grain with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces.
 - 3. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Pipe and Tubing Finishes:
 - 1. 180-Grit Polished Finish: Uniform, directionally textured finish.
 - 2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 - 3. Polished and Buffed Finish: 320-grit finish followed by buffing [to a high luster finish] [to a mirror-like finish] [to match Architect's sample].
- D. Stainless Steel Sheet and Plate Finishes:
 - 1. Directional Satin Finish: ASTM A480/A480, No. 4.
 - 2. High-Luster Finish: ASTM A480/A480M, No. 7.
 - 3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 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**.
 - 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**.
- 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.

- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending **2 inches** beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within **6 inches** of post.

3.4 ANCHORING POSTS

- A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are 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.
- B. Form or core-drill holes not less than **5 inches** deep and **3/4 inch** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with **[nonshrink, nonmetallic grout]** **[or]** **[anchoring cement]**, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, **[welded to post after placing anchoring material]** **[attached to post with setscrews]**.
- D. Leave anchorage joint exposed with **[1/8-inch buildup, sloped away from post]** **[anchoring material flush with adjacent surface]**.
- E. 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:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.
 - 2. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.
 - 3. For stainless steel railings, weld flanges to post and bolt to supporting surfaces.
- F. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with **[sleeves concealed within]** **[flanges connected to]** **[brackets on underside of rails]**

connected to] railing ends and anchored to wall construction with anchors and bolts.

- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and **[welded to railing ends]** **[or]** **[connected to railing ends, using nonwelded connections]**.
- C. Attach handrails to walls with wall brackets **[, except where end flanges are used]**. Provide brackets with **[1-1/2-inch]** **<Insert dimension>** clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt]** **[predrilled hole for exposed bolt anchorage]**.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. 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.
 - 4. For steel-framed partitions, use hanger or lag bolts set into **[fire-retardant-treated]** wood backing between studs. Coordinate with stud installation to locate backing members.
 - 5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.
 - 6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.
- E. Install railing gates level, plumb, and secure for full opening without interference.
 - 1. Attach hardware using tamper-resistant or concealed means.
 - 2. Adjust hardware for smooth operation.

3.6 REPAIR

- A. 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.
 - a. Apply by brush or spray to provide a minimum **2.0-mil** dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in **[Section 099113 "Exterior Painting."]** **[Section 099123 "Interior Painting."]** **[Section 099600 "High-Performance Coatings."]**

3.7 CLEANING

- A. Clean **[aluminum]** **[and]** **[stainless steel]** by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 071353 - ELASTOMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Sheet waterproofing.~~
- ~~2. Plaza-deck pavers.~~

~~B. Related Requirements:~~

- ~~1. Section 071354 "Thermoplastic Sheet Waterproofing" for PVC sheet waterproofing.~~
- ~~2. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for exterior-wall expansion-joint assemblies that interface with waterproofing.~~
- ~~3. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for deck expansion-joint assemblies that interface with waterproofing.~~

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Sustainable Design Submittals:

1. Product data: For waterproofing providing information for testing in compliance with ASHRAE 160-2009.

C. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

D. Samples: For each exposed product and for each color and texture specified, including the following products:

1. **8-by-8-inch** square of waterproofing and flashing sheet.
2. **4-by-4-inch** square of drainage panel.
3. Plaza-deck paver, [**4-by-4-inch square**] [**full sized**], in each color and texture required.
4. Paver pedestal assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 1. Build for each typical waterproofing installation including [**pavers and**] accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.
 - a. Size: [**100 sq. ft. in area**] [**As indicated on Drawings**].
 - b. Description: Each type of [**wall**] [**deck**] [**and**] [**plaza**] <Insert description> installation.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 1. Warranty Period: [**10**] [**20**] <Insert number> years from date of Substantial Completion.

- B. Installer's Special Warranty: Specified form, **[on warranty form at end of this Section,]** signed by Installer, covering Work of this Section, for warranty period of **[two]** ~~<Insert number>~~ years.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials[, **protection course,**] **[and] [molded-sheet drainage panels]** from single source from single manufacturer.
- B. Source Limitations for Plaza-Deck Paving: Obtain plaza-deck pavers[**and paver pedestals**] from single source from single manufacturer.

2.2 ACCESSORIES

- A. Furnish accessory materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type accessory materials that comply with VOC limits of authorities having jurisdiction.
- B. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or **60-mil-** thick, uncured EPDM, as required by manufacturer.
- C. Exposed Sheet Flashing: **60-mil-** thick EPDM, cured or uncured, as required by manufacturer.
- D. Bonding Adhesives: For bonding waterproofing sheets and sheet flashings to substrates and projections.
- E. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.
 - 1. Butyl Gum Tape: **30-mil-** thick by **6-1/4-inch-** wide, uncured butyl with polyethylene release film.
- F. Lap Sealant: Single-component sealant.
- G. In-Seam Sealant: Single-component sealant.
- H. Water-Cutoff Mastic: Butyl mastic sealant.
- I. Waterproofing and Sheet-Flashing Accessories: Sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.
- J. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately **1 inch** wide, prepunched, with fasteners.
- K. Semirigid sheets of asphalt-impregnated organic mat, mineral surface, with a nominal thickness of **1/8 inch**.
- L. Fan folded, with a core of extruded-polystyrene board insulation, a nominal thickness of **1/4 inch**, and a compressive strength of not

less than **8 psi**.

~~2.3 INSULATION DRAINAGE PANELS~~

~~A. Insulation: Comply with Section 072100 "Thermal Insulation" for general building insulation[, including insulation drainage panels].~~

~~2.4 PLAZA-DECK PAVERS~~

~~A. Plaza-Deck Pavers: [Brick] [Concrete] [Asphalt block] pavers specified in Section 321400 "Unit Paving."~~

~~B. Stone Plaza-Deck Pavers: [Granite] [Limestone] [Marble] [Quartz-based stone] [Slate] [Travertine] <Insert type> pavers specified in Section 321400 "Unit Paving."~~

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 waterproofing.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.
- F. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF FULLY ADHERED SHEET

- A. Install fully adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions and in accordance with recommendations in ASTM D5843.
- B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
- C. Apply bonding adhesive to substrates at required rate and allow it to partially dry.
- D. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
- E. Install fully adhered sheets and accessory materials to tie into existing waterproofing.
- F. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
- G. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.
 - 1. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

3.4 INSTALLATION OF PARTIALLY ADHERED SHEET

- A. Install partially adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions.
- B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
- C. Apply bonding adhesive to the following areas of substrates and to each sheet at required rate and allow it to partially dry:
 - 1. Upper 25 percent of length of each sheet and **18 inches** around perimeter of each sheet.
- D. Firmly adhere sheets to substrate. Do not apply bonding adhesive to splice area of sheet.
- E. Install partially adhered sheets and accessory materials to tie into existing waterproofing.
- F. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

3.5 INSTALLATION OF COMPARTMENTED, LOOSELY LAID SHEET

- A. Install compartmented, loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.
- B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
- C. Apply continuous beads of water-cutoff mastic, of size recommended in writing by waterproofing manufacturer, to substrates in a **60-by-60-inch** grid pattern before installing sheet.
- D. Apply sheets with side laps shingled with slope of deck where possible.

- E. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.
- F. Install compartmented, loosely laid sheets and accessory materials to tie into existing waterproofing.
- G. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

3.6 INSTALLATION OF SEAMS

- A. Cement Splice: Clean splice areas, apply splicing cement and in-seam sealant, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to produce a splice not less than **6 inches** wide and to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.
- B. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal edges of sheet terminations.

3.7 INSTALLATION OF SHEET FLASHING

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to waterproofing manufacturer's written instructions.
- B. Form wall flashings using exposed sheet flashing.
- C. Extend deck sheet waterproofing to form wall flashings.
 - 1. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
 - 2. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal edges of sheet-flashing terminations.
- D. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.
- E. Terminate and seal top of sheet flashings[**with mechanically anchored termination bars**].

3.8 INSTALLATION OF PROTECTION COURSE

- A. Install protection course over waterproofing membrane according to manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.
 - 1. **[Molded-sheet drainage panels]** **[Insulation drainage panels]** **[Board insulation]** may be used in place of a separate protection course for vertical applications when approved by waterproofing manufacturer.

3.9 INSTALLATION OF MOLDED-SHEET DRAINAGE PANEL

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to

maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install [board insulation] [protection course] before installing drainage panels.

3.10 INSTALLATION OF INSULATION DRAINAGE PANEL

- A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within **3/4 inch** of projections and penetrations.
- B. Ensure that drainage channels are aligned and free of obstructions.
- C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.
- D. On horizontal surfaces, loosely lay insulation drainage panels according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

~~3.11 INSTALLATION OF PLAZA-DECK PAVERS~~

- ~~A. Install pavers according to manufacturer's written instructions.~~
- ~~B. Install paver pedestals and accessories to required elevations. Adjust for final level and slope of paved surfaces.~~
- ~~C. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.~~
- ~~1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.~~
- ~~D. Install pavers to vary no more than 1/16 inch in elevation between adjacent pavers and no more than 1/16 inch from surface plane elevation of individual paver.~~
- ~~E. Limit variation in paving installation to within [1/4 inch in 10 feet] <Insert dimensions> of surface plane in any direction; noncumulative.~~

3.123.11 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests.
- B. Manufacturer's Field Service: Engage a [full-time] site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.
- C. Flood Testing: Flood test each deck area for leaks, in accordance with procedures in ASTM D5957, after completing waterproofing but before placing overlying construction. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 1. Flood to an average depth of **2-1/2 inches** with a minimum depth of **1 inch** and a maximum depth of **4 inches**. Maintain **2 inches** of clearance from top of sheet flashings.
 2. Flood each area for [24] [48] [72] hours.
 3. Testing agency is to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood

- testing.
- 4. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
- D. Waterproofing will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.133.12 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071353

SECTION 072500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building paper.
- ~~2. Building wrap.~~
- ~~3. Drainage wrap.~~
- ~~4. Flexible flashing.~~
- ~~5. Drainage material.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Building paper.
2. Building wrap.
3. Drainage wrap.
4. Flexible flashing.
5. Drainage material.

B. Product Data Submittals: For **[building wrap]** **[drainage wrap]**, include data on air and water-vapor permeance based on testing in accordance with referenced standards.

C. Shop Drawings: Show details of **[building paper]** **[building wrap]** **[drainage wrap]** at terminations, openings, and penetrations. Show details of flexible flashing applications.

D. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.
9. Health Product Declaration (HPD): For each product.
10. Health Product Declaration (HPD): Provide HPD.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For ~~[water-resistive barrier]~~ ~~[and]~~ ~~[flexible flashing]~~, from ICC-ES.

PART 2 - PRODUCTS

2.1 ~~WATER-RESISTIVE BARRIER~~

- A. ~~Building Paper:~~

- ~~1. ASTM D226/D226M, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.~~
- ~~2. Water-vapor-permeable, asphalt-saturated kraft building paper that complies with ICC-ES AC308, Grade DI; **except with water-resistance rating not less than 1 hour**.~~

2.2 ~~FLEXIBLE FLASHING~~

- A. ~~Primer for Flexible Flashing: Product recommended in writing by flexible flashing manufacturer for substrate.~~
- B. ~~Nails and Staples: Product recommended in writing by flexible flashing manufacturer and complying with ASTM F1667.~~

2.3 ~~DRAINAGE MATERIAL~~

- A. ~~Drainage Accessories: ~~[Furring strips]~~ ~~<Insert component>~~ installed between water-resistive barrier and exterior cladding to create a continuous open space behind exterior cladding.~~

PART 3 - EXECUTION

3.1 ~~INSTALLATION OF WATER-RESISTIVE BARRIER~~

- A. ~~Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.~~
- B. ~~Cover sheathing with water-resistive barrier as follows:~~
- ~~1. Cut back barrier **1/2 inch** on each side of the break in supporting members at expansion or control joint locations.~~
 - ~~2. Apply barrier to cover vertical flashing with a minimum **4 inch** overlap unless otherwise indicated.~~
- C. ~~Building Paper: Apply horizontally with a **2 inch** overlap and a **6 inch** end lap; fasten to sheathing with galvanized staples or roofing nails.~~
- D. ~~Building Wrap or Drainage Wrap: Comply with manufacturer's written instructions and warranty requirements.~~
- ~~1. Seal seams, edges, fasteners, and penetrations with tape.~~
 - ~~2. Extend into jambs of openings and seal corners with tape.~~

3.2 — INSTALLATION OF FLEXIBLE FLASHING

A. — Apply flexible flashing where indicated to comply with manufacturer's written instructions.

1. — Prime substrates as recommended by flashing manufacturer.
2. — Lap seams and junctures with other materials at least **4 inches** except that at flashing flanges of other construction, laps need not exceed flange width.
3. — Lap flashing over water-resistive barrier at bottom and sides of openings.
4. — Lap water-resistive barrier over flashing at heads of openings.
5. — After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

3.3 — INSTALLATION OF DRAINAGE MATERIAL

A. — Install drainage material over building wrap and flashing to comply with manufacturer's written instructions.

END OF SECTION 072500

SECTION 072600 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.
- ~~2. Reinforced-polyethylene vapor retarders.~~
- ~~3. Fire-retardant, reinforced-polyethylene vapor retarders.~~

~~B. Related Requirements:~~

- ~~1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.~~
- ~~2. Section 072100 "Thermal Insulation" for vapor retarders integral with insulation products.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.
3. Fire-retardant, reinforced-polyethylene vapor retarders.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D4397, [~~6-mil~~] [~~10-mil~~] thick sheet, with maximum permeance rating of **0.1 perm.**

2.2 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Place vapor retarders on side of construction indicated on Drawings.
- B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.
- D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 INSTALLATION OF VAPOR RETARDERS IN CRAWL SPACES

- A. Install vapor retarders over prepared grade. Lap joints a minimum of **12 inches** and seal with manufacturer's recommended tape. Install second layer over pathways to equipment.
- B. Extend vapor retarder over footings and seal to foundation wall or grade beam with manufacturer's recommended tape.
 - 1. Extend vapor retarder vertically minimum **[16 inches] [24 inches]** **<Insert dimension>** above top of footing.
- C. Seal around penetrations such as utilities and columns in order to create a monolithic, airtight membrane at grade surface, perimeter, and all vertical penetrations.

3.4 PROTECTION

- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 072600

SECTION 074616 - ALUMINUM SIDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Aluminum siding.~~
- ~~2. Aluminum soffit.~~

~~B. Related Requirements:~~

- ~~1. Section 061000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.~~
- ~~2. Section 062013 "Exterior Finish Carpentry" for exterior [cellular PVC] [and] [foam plastic] trim.~~
- ~~3. Section 072500 "Weather Barriers" for weather-resistive barriers.~~

1.2 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Aluminum siding.
2. Aluminum soffit.

- B. Product Data Submittals: [Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.]

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

- D. Samples for Initial Selection: For aluminum [siding] [and] [soffit] including related accessories.

- E. Samples for Verification: [For each type, color, texture, and pattern required.]

1. ~~12-inch~~ long-by-actual-width Sample of siding.

2. ~~24-inch~~ wide-by-~~36-inch~~ high Sample panel of siding assembled on plywood backing.
3. ~~12-inch~~ long-by-actual-width Sample of soffit.
4. ~~12-inch~~ long-by-actual-width Samples of trim and accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of aluminum [siding] [and] [soffit].
- B. Research/Evaluation Reports: For each type of aluminum siding required, from ICC-ES.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Furnish full lengths of aluminum [siding] [and] [soffit] including related accessories, in a quantity equal to 2 percent of amount installed.

1.8 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 1. Build mockup of typical wall area as shown on Drawings.
 2. Build mockups for [siding] [and] [soffit] including accessories.
 - a. Size: [~~48 inches~~ long by ~~60 inches~~ high] <Insert dimensions>.
 - b. Include outside corner on one end of mockup [and inside corner on other end].
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracking[, **fading**,] and deforming.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. **<Insert failure modes>**.
 2. Fading is defined as loss of color, after cleaning with product recommended by manufacturer, of more than [4] [5] [7] Hunter color-difference units as measured in accordance with ASTM D2244.
 3. Warranty Period: [10] [25] [50] **<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain products, including related accessories, from single source from single manufacturer.

2.2 ~~ALUMINUM SIDING~~

A. ~~Horizontal Pattern:~~

- ~~1. 8-inch exposure in [plain, single board] [beaded-edge, single board] [plain, double, 4-inch board] <Insert requirement> style.~~
- ~~2. 10-inch exposure in [plain,] [Dutch-lap,] <Insert requirement> double, 5-inch board style.~~

B. ~~Vertical Pattern: [12-inch exposure in board-and-batten, single-board style] [16-inch exposure in V-grooved, triple, 5-1/3-inch board style].~~

C. ~~Texture: [Smooth] [Wood-grain] <Insert requirement>.~~

D. ~~Nominal Thickness: [0.019 inch] [0.024 inch] <Insert dimension>.~~

E. ~~Insulation: Manufacturer's standard integral insulation panels.~~

F. ~~Finish: Manufacturer's standard [three-coat PVDF] [primer and baked-on acrylic] [primer and baked-on polyester] <Insert requirement>.~~

- ~~1. Colors: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range of colors].~~

2.3 ~~ALUMINUM SOFFIT~~

A. ~~Pattern:~~

1. ~~6-inch~~ exposure in V-grooved, single-board style.
2. ~~10-inch~~ exposure in V-grooved, double, ~~5-inch~~ board style.
3. ~~12-inch~~ exposure in V-grooved, double, ~~6-inch~~ board style.
4. ~~16-inch~~ exposure in V-grooved, ~~[triple, 5-1/3-inch]~~ ~~[quadruple, 4-inch]~~ ~~<Insert requirement>~~ board style.

B. ~~Texture: [Smooth] [Wood grain] <Insert requirement>.~~

C. ~~Ventilation: Provide [perforated] [unperforated] soffit [unless otherwise indicated].~~

D. ~~Nominal Thickness: [0.019 inch] [0.024 inch] <Insert dimension>.~~

E. ~~Finish: Manufacturer's standard [three-coat PVDF] [primer and baked-on acrylic] [primer and baked-on polyester] <Insert requirement>.~~

1. ~~Colors: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range of colors] [Match adjacent siding].~~

2.42.2 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories ~~[made from same material as] [matching color and texture of]~~ adjacent siding unless otherwise indicated.

B. Aluminum Accessories: Where aluminum accessories are indicated, provide accessories complying with AAMA 1402.

1. Texture: ~~[Smooth] [Wood grain] <Insert requirement>.~~
2. Nominal Thickness: ~~[0.019 inch] [0.024 inch] <Insert dimension>.~~
3. Finish: Manufacturer's standard ~~[three-coat PVDF] [primer and baked-on acrylic] [primer and baked-on polyester] <Insert requirement>.~~

C. Decorative Accessories: Provide the following aluminum decorative accessories as indicated:

1. Corner posts ~~[with fluted faces].~~
2. Door and window casings ~~[with fluted faces].~~
3. Entrance and window head pediments.
4. Pilasters ~~[with fluted faces].~~
5. Shutters with ~~[paneled] [louvered]~~ faces.
6. Louvers.
7. Fasciae.
8. Moldings and trim.
9. ~~<Insert accessories>.~~

D. Colors for Decorative Accessories: ~~[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range of colors] [Match adjacent siding].~~

E. Flashing: Provide aluminum flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.

1. Finish for Aluminum Flashing: [Same as aluminum siding] [Siliconized polyester coating, same color as siding] [High-performance organic finish, same color as siding] [Factory-prime coating] <Insert finish>.
- F. Fasteners:
1. For fastening to wood, use [siding nails] [ribbed bugle-head screws] of sufficient length to penetrate a minimum of **1 inch** into substrate.
 2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of **1/4 inch**, or three screw-threads, into substrate.
 3. For fastening aluminum, use aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.
- G. Insect Screening for Soffit Vents: [Aluminum, **18-by-16 mesh**] [PVC-coated, glass-fiber fabric, **18-by-14 or 18-by-16 mesh**] <Insert requirement>.
- H. Continuous Soffit Vents: Aluminum, hat-channel shape, with [stamped louvers] [perforations]; **2 inches** wide and not less than **96 inches** long.
1. Net-Free Area: [**4 sq. in./linear ft.**] [**6 sq. in./linear ft.**] [**8 sq. in./linear ft.**] <Insert dimension>.
 2. Finish: [Mill finish] [White paint] [Brown paint] <Insert requirement>.
- I. Round Soffit Vents: Stamped aluminum louvered vents, [**2 inches**] [**2-1/2 inches**] [**3 inches**] [**4 inches**] <Insert dimension> in diameter, made to be inserted in round holes cut into soffit.
1. Finish: [Mill finish] [White paint] [Brown paint] <Insert requirement>.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of aluminum [siding] [and] [soffit] and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 1. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

- B. Install aluminum [siding] [and] [soffit] and related accessories in accordance with AAMA 1402.
 - 1. Install fasteners no more than [24 inches] <Insert dimension> o.c.
- C. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.
- D. Where aluminum siding contacts dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces in accordance with manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074616

SECTION 075113 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Built-up asphalt roofing.~~
- ~~2.1. Roofing membrane sheet materials.~~
- ~~3.2. Base flashing sheet materials.~~
- ~~4.3. Asphalt materials.~~
- ~~5.4. Accessory roofing materials.~~
- ~~6. Substrate board.~~
- ~~7. Vapor retarder.~~
- ~~8. Roof insulation.~~
- ~~9. Insulation accessories and cover board.~~
- ~~10. Electronic leak detection (ELD) materials.~~
- ~~11.5. Coating materials.~~
- ~~12.6. Walkways.~~

~~B. Section includes the installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."~~

~~C. B.~~ Related Requirements:

- 1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
- 2. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
- 3. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
- 4. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
- 5. Section 077100 "Roof Specialties" for [premanufactured metal copings] [roof edge fasciae] [gravel stops] [reglets] [roof edge flashings] [counterflashings].
- 6. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
- 7. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
- 8. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

- A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at [Project site] <Insert location>.

1. Meet with Owner, [**Construction Manager**,] Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at [**Project site**] <Insert location>.

1. Meet with Owner, [**Construction Manager**,] Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Built-up asphalt roofing.
2. Roofing membrane sheet materials.
3. Base flashing sheet materials.
4. Asphalt materials.
5. Accessory roofing materials.
6. Substrate board.
7. Vapor retarder.
8. Roof insulation.
9. Insulation accessories and cover board.
10. Electronic leak detection (ELD) materials.
11. Coating materials.
12. Walkways.

B. Product Data Submittals:

1. For insulation and roof system component fasteners, include copy of **[FM Approvals' RoofNav]** **[SPRI's Directory of Roof Assemblies]** listing.
- C. Sustainable Design Submittals:
 1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
- D. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:
 1. Layout and thickness of insulation.
 2. Base flashings and roofing terminations.
 3. Flashing details at penetrations.
 4. Tapered insulation, including slopes.
 5. Roof plan showing orientation of steel roof deck and roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
 6. Crickets, saddles, and tapered edge strips, including slopes.
 7. Insulation-fastening patterns for corner, perimeter, and field-of-roof locations.
 8. Tie-in with adjoining air barrier.
- E. Samples for Verification: For the following products:
 1. Cap Sheet: Samples of **[manufacturer's standard colors for selection by Architect]** **[specified color]**.
 2. Flashing Sheet: Samples of **[manufacturer's standard colors for selection by Architect]** **[specified color]**.
 3. Aggregate surfacing material in gradation **[and color]** required.
 4. Roof paver **[, full sized,]** in each color and texture required.
 5. Walkway Pads or Rolls: Samples of **[manufacturer's standard colors for selection by Architect]** **[specified color]**.
- F. Wind Uplift Resistance Submittal: For roofing system indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[Installer]** **[manufacturer]** **[and]** **[testing agency]**.
- B. 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.
- C. Product Test Reports: For roof insulation, tests performed by a qualified testing agency, indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

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

B. Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. **Manufacturer Qualifications:** A qualified manufacturer that is [UL listed] [listed in FM Approvals' RoofNav] [listed in SPRI's Directory of Roof Assemblies] for roofing system identical to that used for this Project.

B. **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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. **Weather Limitations:** Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in

accordance with manufacturer's written instructions and warranty requirements.

1.10 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. Special warranty includes roofing membrane, base flashings, [roof insulation,] [fasteners,] [cover boards,] [vapor retarder] [substrate board,] [roof pavers,] and other components of roofing system.
 - 2. Warranty Period: [10] [15] [20] <Insert number> years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system, such as roofing membrane, base flashing, [roof insulation,] [fasteners,] [cover boards,] [substrate boards,] [vapor retarders,] [roof pavers,] and [walkway products,] for the following warranty period:
 - 1. Warranty Period: [Two] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.
 - 1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746/C3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:
 - 1. Zone 1 (Roof Area Field): <Insert lbf/sq. ft.>.
 - 2. Zone 2 (Roof Area Perimeter): <Insert lbf/sq. ft.>.
 - a. Location: From roof edge to <Insert dimension> inside roof edge.
 - 3. Zone 3 (Roof Area Corners): <Insert lbf/sq. ft.>.
 - a. Location: <Insert dimension> in each direction from each building corner.
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals

4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: [Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>.
 2. Hail-Resistance Rating: FM 1-34 [MH] [SH] [VSH].
- E. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical to that specified for this Project.
1. Wind Uplift Load Capacity: [60 psf] [75 psf] [90 psf] [105 psf] [120 psf] <Insert capacity>.
- F. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [64] [32] or initial SRI not less than [82] [39] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- H. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- I. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [64] [15] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- J. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- K. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for [low] [steep]-slope roof products.
- L. Energy Performance: Roofing system to have an initial solar reflectance of not less than [0.70] <Insert value> and an emissivity of not less than [0.75] <Insert value> when tested in accordance with ANSI/CRRC S100.
- M. Exterior Fire-Test Exposure: ASTM E108 or UL 790, [Class A] [Class B] [Class C]; for application and roof slopes indicated; testing by a qualified testing agency.
1. Identify products with appropriate markings of applicable testing agency.
- N. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.
1. Identify products with appropriate markings of applicable testing agency.

2.2 BUILT-UP ASPHALT ROOFING

- A. Source Limitations: Obtain components for roofing system from [same manufacturer as roofing membrane] [or] [manufacturer approved by roofing membrane manufacturer].

2.32.2 ROOFING MEMBRANE SHEET MATERIALS

- A. SBS-Modified-Bitumen, Glass-Fiber-Mat Base Sheet: ASTM D6163/D6163M, [Type I] [Type II] [Type III], SBS-modified asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
- B. Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, [Type I] [Type II], nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
- C. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897/D4897M, Type II, venting, nonperforated, asphalt-impregnated and -coated, glass-fiber base sheet with mineral granule surfacing on bottom surface.
- D. Asphalt-Coated, Organic-Felt Base Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
- E. Ply Sheet: ASTM D2178/D2178M, [Type IV] [Type VI], asphalt-impregnated, glass-fiber felt.
- F. Cap Sheet: ASTM D3909/D3909M, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

2.42.3 BASE FLASHING SHEET MATERIALS

- A. Asphalt-Impregnated, Glass-Fiber-Mat Backer Sheet: ASTM D2178/D2178M, [Type IV] [Type VI], asphalt-impregnated, glass-fiber felt.
- B. Asphalt-Coated, Glass-Fiber-Mat Backer Sheet: ASTM D4601/D4601M, [Type I] [Type II], asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
- C. Asphalt-Coated, Organic-Felt Backer Sheet: ASTM D2626/D2626M, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
- D. SBS-Modified-Bitumen Backer Sheet: [ASTM D6164/D6164M, Type I or II, Grade S, reinforced with polyester fabric] [ASTM D6163/D6163M, Type I or II, Grade S, reinforced with glass fibers] [ASTM D6162/D6162M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers]; smooth surfaced; suitable for application method specified.
- E. SBS-Modified-Bitumen, Granule-Surfaced Flashing Sheet: [ASTM D6164/D6164M, Type I or II, Grade G, polyester reinforced] [ASTM D6163/D6163M, Type I or II, Grade G, glass-fiber reinforced] [ASTM D6162/D6162M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers], granule-surfaced; suitable for application method specified, and as follows:
 - 1. Granule Color: [White] [Gray] [Tan] <Insert color>.
- F. SBS-Modified-Bitumen, Metal-Surfaced Flashing Sheet: ASTM D6298, glass-fiber-reinforced, SBS-modified, metal-foil-surfaced asphalt sheet, suitable for application method specified, and as follows:
 - 1. Metal Surfacing: [Aluminum] [Copper] [Stainless steel] [Aluminum, fluoropolymer-coated finish, of color and gloss selected by Architect from manufacturer's full range].
- G. APP-Modified-Bitumen, Smooth-Surfaced Flashing Sheet: [ASTM D6222/D6222M, Type I or II, Grade S, polyester-reinforced] [ASTM D6223/D6223M, Type I or II, Grade S, reinforced with a combination of polyester fabric and glass fibers], smooth surfaced, suitable for application method specified.

- H. APP-Modified-Bitumen, Granule-Surfaced Flashing Sheet: **[ASTM D6222/D6222M, Type I or II, Grade G, polyester-reinforced] [ASTM D6223/D6223M, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers]**, granule-surfaced, suitable for application method specified, and as follows:
 - 1. Granule Color: **[White] [Gray] [Tan] <Insert color>**.
- I. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D1668/D1668M, Type I.
- J. Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

2.52.4 ASPHALT MATERIALS

- A. Asphalt Primer: ASTM D41/D41M.
- B. Roofing Asphalt: ASTM D312/D312M, **[Type III] [Type IV] [Type III or IV as recommended by roofing system manufacturer for application] <Insert type>**.
- C. SEBS-Modified Roofing Asphalt: ASTM D6152/D6152M.

2.62.5 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants shall 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.
 - 3. Adhesives and sealants 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."
 - 4. Adhesives and sealants 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."
 - 5. Adhesives and sealants 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

6. Adhesives and sealants 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."
 7. Adhesives and sealants 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- B. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- C. Roof Vents: As recommended by roof membrane manufacturer.
1. Size: Not less than **4-inch** diameter.
- D. Sheathing Paper: Red-rosin type, minimum **3 lb/100 sq. ft.**
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately **1 by 1/8 inch** thick; with anchors.
1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
- F. Cold-Applied Trichloroethylene Asphalt Adhesive: ASTM D3019, Type III, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.
- G. Cold-Applied Asphalt Adhesive: ASTM D4479/D4479M, Type I or Type II, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.
- H. Cold-Applied Polymer-Modified Asphalt Adhesive: Roof membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system, base flashings, and aggregate surfacing adhesive.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing manufacturer for application.
- J. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
- K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
- L. Aggregate Surfacing: ASTM D1863/D1863M, No. 6 or No. 67, clean, dry, opaque, **[water-worn gravel or crushed stone, free of sharp edges] [crushed slag, free of sharp edges]**.
- M. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.7 SUBSTRATE BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: ~~5/8 inch~~.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: ~~[1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]~~.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.

C. Perlite Board: ASTM C728, seal coated.

1. Thickness: ~~[3/4 inch] [1 inch]~~.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.

2.8 VAPOR RETARDER

A. Polyethylene Film: ASTM D4397, ~~[6 mils] [10 mils]~~ thick, minimum, with maximum permeance rating of ~~[0.13 perm] [0.76 perm]~~.

1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
2. Adhesive: Manufacturer's standard lap adhesive, FM Global approved for vapor-retarder application.

B. Rubberized Asphalt Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum ~~40-mil~~ total thickness; maximum permeance rating of ~~0.1 perm~~; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

C. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum ~~30-mil~~ total thickness; maximum permeance rating of ~~0.1 perm~~; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.

2.9 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured ~~[or approved]~~ by roof membrane manufacturer, ~~[approved for use in FM~~

~~Approvals' RoofNav-listed roof assemblies] [, approved for use in SPRI's Directory of Roof Assemblies-listed roof assemblies].~~

B. ~~Mineral Wool Insulation - Multidensity: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer with an 11.2-lb/cu. ft. density and a lower layer with a 7.5-lb/cu. ft. density.~~

1. ~~Thermal Resistance: R-value of 3.8 per 1 inch.~~

2. ~~Size: 48 by 48 inches.~~

3. ~~Thickness:~~

a. ~~Base Layer: [2 inches] <Insert thickness>.~~

b. ~~Upper Layer: <Insert thickness>.~~

4. ~~Face Treatment: Bitumen coating.~~

5. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

C. ~~Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having a 12.5-lb/cu. ft. density.~~

1. ~~Thermal Resistance: R-value of 4.0 per 1 inch.~~

2. ~~Size: 48 by 48 inches.~~

3. ~~Thickness: 1 inch.~~

4. ~~Face Treatment: Bitumen coating.~~

5. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

D. ~~Tapered Insulation: Provide factory-tapered insulation boards.~~

1. ~~Material: [Match roof insulation] <Insert material>.~~

2. ~~Minimum Thickness: 1/4 inch.~~

3. ~~Slope:~~

a. ~~Roof Field: [1/4 inch per foot] <Insert slope> unless otherwise indicated on Drawings.~~

b. ~~Saddles and Crickets: [1/2 inch per foot] <Insert slope> unless otherwise indicated on Drawings.~~

4. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

2.10 INSULATION ACCESSORIES AND COVER BOARD

A. ~~General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with other roofing system components.~~

B. ~~Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation [and cover board] to substrate and acceptable to roofing manufacturer.~~

1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

- C. ~~Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:~~
1. ~~Modified asphaltic, asbestos-free, cold-applied adhesive.~~
 2. ~~Bead-applied, low-rise, one-component or multicomponent urethane adhesive.~~
 3. ~~Full-spread spray-applied, low-rise, two-component urethane adhesive.~~
 4. ~~Adhesives and sealants shall 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.~~
 5. ~~Adhesives and sealants 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."~~
 6. ~~Adhesives and sealants 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."~~
 7. ~~Adhesives and sealants 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.~~
 8. ~~Adhesives and sealants 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."~~
 9. ~~Adhesives and sealants 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.~~
- D. ~~Insulation Cant Strips: [ASTM C728, perlite insulation board] [ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board].~~
- E. ~~Wood Nailer Strips: Comply with requirements in Section 061000 "Rough Carpentry."~~
- F. ~~Tapered Edge Strips: [ASTM C728, perlite insulation board] [ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board].~~
- G. ~~Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of 40 psi.~~
1. ~~Thickness: [1/2 inch] [1 inch] <Insert thickness>.~~
 2. ~~Surface Finish: [Primed one side] [Primed two sides with non-asphaltic primer] [Integral coating, six sides] [Unprimed] <Insert finish>.~~

3. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

H. ~~Oriented Strand Board: DOC PS 2, Exposure 1, 7/16 inch thick.~~

1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

I. ~~Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber-reinforced, water-resistant gypsum board.~~

1. ~~Thickness: [1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch].~~

2. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

J. ~~Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.~~

1. ~~Thickness: [7/16 inch] [1/2 inch] [5/8 inch].~~

2. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

K. ~~Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, 1/2 inch thick, having a minimum compressive strength of 80 psi.~~

1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~

L. ~~Joint Tape: 6- or 8-inch wide, coated, glass fiber.~~

2.11 ~~ELECTRONIC LEAK DETECTION (ELD) MATERIALS~~

A. ~~Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.~~

2.122.6 COATING MATERIALS

A. Roof Coating:

1. ASTM D1227, Type II, [Class 1, mineral-colloid-emulsified, fibered] [Class 2, chemically emulsified, filled or fibered] asphalt emulsion, asbestos free.
2. ASTM D1227, Type III, [Class 1, mineral-colloid-emulsified] [Class 2, chemically emulsified] asphalt emulsion, nonfibered.
3. ASTM D2824/D2824M, [Type I, nonfibered] [Type III, fibered, asbestos-free] aluminum-pigmented asphaltic coating.
4. ASTM D6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.

a. Color: [White] [Gray] [Tan] <Insert color>.

2.132.7 WALKWAYS

- A. Walkway Pads: [Mineral-granule-surfaced, reinforced asphaltic composition] [Polymer-modified, reconstituted solid-rubber, surface-textured], slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer, [3/8 inch] [1/2 inch] [3/4 inch] thick, minimum.
1. Pad Size: Approximately [36 by 60 inches] <Insert size>.
 2. Color: Contrasting with cap sheet.
- B. Walkway Cap-Sheet Strips: [ASTM D6164/D6164M, Type I or II, Grade G, polyester-reinforced] [ASTM D6163, Type I or II, Grade G, glass-fiber-reinforced] [ASTM D6162, Type I or II, Grade G, reinforced with a combination of polyester fabric and glass fibers], SBS-modified asphalt sheet; granule surfaced; suitable for application method specified, and as follows:
1. Size: [36 by 60 inches] <Insert size>.
 2. Granule Color: [White] [Gray] [Tan] <Insert color>.
- C. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, [square edged] [with top edges beveled 3/16 inch], factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:
1. Size: [24 by 24 inches] <Insert dimensions>. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.
 2. Weight: <Insert weight>.
 3. Compressive Strength: [7500 psi] [6500 psi] <Insert value>, minimum; ASTM C140/C140M.
 4. Colors and Textures: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
 4. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
 5. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
 6. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than [75] <Insert number> percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.
 - a. Test Frequency: One test probe per each [1000 sq. ft.] <Insert area>, or portion thereof, of roof deck, with not less

- than three test probes.
 - b. Submit test reports within 24 hours of performing tests.
 - 7. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
 - 8. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
 - 9. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
 - 10. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
 - 11. Verify that adjacent cementitious wood fiber panels are vertically aligned to within **1/8-inch** at top surface.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing manufacturer's written instructions.
 - 1. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
 - 1. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Prime surface of concrete deck with asphalt primer at a rate of **3/4 gal./100 sq. ft.**, and allow primer to dry.
- D. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours of performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
- E. Install sound-absorbing insulation strips in ribs of acoustical roof decks in accordance with acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system in accordance with manufacturer's written instructions, **[FM Approvals' RoofNav] [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 the end of the workday or when rain is forecast.
 - 1. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition **[and to not void warranty for existing roofing system]**.

- D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under [Section 072713 "Modified Bituminous Sheet Air Barriers."] [Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."] [Section 072726 "Fluid-Applied Membrane Air Barriers."]
- E. Asphalt Heating:
 - 1. Heat asphalt to its equiviscous temperature, measured at the mop cart or mechanical spreader immediately before application.
 - 2. Circulate asphalt during heating.
 - a. Do not raise asphalt temperature above equiviscous temperature range more than one hour before time of application.
 - 3. Do not exceed asphalt manufacturer's recommended temperature limits during asphalt heating.
 - 4. Do not heat asphalt within **25 deg F** of flash point.
 - 5. Discard asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
 - a. Apply hot roofing asphalt within plus or minus **25 deg F** of equiviscous temperature.
- F. SEBS-Modified Asphalt Heating: Heat and apply roofing asphalt in accordance with roofing manufacturer's written instructions.
- G. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing components or adjacent building construction.

3.4 — INSTALLATION OF SUBSTRATE BOARD

- A. — Install substrate board with long joints in continuous straight lines, with end joints staggered not less than **24 inches** in adjacent rows.
 - 1. — At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. — Locate end joints over crests of steel roof deck.
 - 2. — Tightly butt substrate boards together.
 - 3. — Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. — Fasten substrate board to top flanges of steel deck in accordance with recommendations in [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [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.
 - 5. — Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturer's written instructions.
 - 6. — Loosely lay substrate board over roof deck.

3.5 — INSTALLATION OF VAPOR RETARDER

- A. — Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of **2 and 6 inches**, respectively.
 - 1. — Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
 - 2. — Continuously seal side and end laps with [tape] [adhesive].

- B. ~~Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.~~
- ~~1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.~~
 - ~~2. Continuously seal side and end laps with tape.~~
- C. ~~Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.~~
- ~~1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.~~
 - ~~2. Seal laps by rolling.~~
- D. ~~Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches over preceding felt.~~
- ~~1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.~~
 - ~~2. Embed each felt in a solid mopping of hot roofing asphalt.~~
 - ~~3. Glaze coat completed surface with hot roofing asphalt.~~
- E. ~~Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.~~

3.63.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install one lapped base sheet course and mechanically fasten to substrate in accordance with roofing membrane manufacturer's written instructions.
- D. Nailer Strips: Mechanically fasten **4-inch nominal**, width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
1. **[16 feet]** **<Insert dimension>** apart for roof slopes greater than **1 inch per 12 inches** but less than **3 inches per 12 inches**.
 2. **[48 inches]** **<Insert dimension>** apart for roof slopes greater than **3 inches per 12 inches**.
- E. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane with vertical surfaces or angle changes greater than 45 degrees.
- F. Installation Over Metal Decking:
1. Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows]** **[end joints staggered not less than 12 inches in adjacent rows]** **[and with long joints continuous at right angle to flutes of decking]**.
 - a. Locate end joints over crests of decking.
 - b. 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.
 - 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** 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**.
 - 1) Trim insulation so that the flow of water is not restricted.
 - f. Fill gaps exceeding **1/4 inch** with insulation.
 - g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - h. Mechanically attach base layer of insulation[**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation in accordance with requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity].
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation[**and tapered insulation**], with joints of each layer offset not less than **12 inches** from previous layer of insulation.
- a. Staggered end joints within each layer not less than **24 inches** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches** 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** 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**.
 - f. Trim insulation so that water flow of water is unrestricted.
 - g. Fill gaps exceeding **1/4 inch** with insulation.
 - h. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - i. Adhere each layer of insulation to substrate using adhesive in accordance with [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [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** 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.
- G. Installation Over Wood and Wood Panel Decking:
1. Mechanically fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to [wood] [wood panel] decks.
- a. Lap edges a minimum of **2 inches**, or as recommended by roof membrane manufacturer
 - b. Lap ends a minimum of **6 inches**, or as recommended by roof membrane manufacturer.
 - c. Fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.

- d. Fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install base layer of insulation with [joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches 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 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.
 - 1) Trim insulation so that the flow of water is not restricted.
 - e. Fill gaps exceeding 1/4 inch with insulation.
 - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - g. Mechanically attach base layer of insulation [and substrate board] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to [wood] [wood panel] decks.
 - 1) Fasten insulation in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - h. Adhere base layer of insulation to substrate using adhesive as follows:
 - 1) Set base layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set base layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set base layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
3. Install upper layers of insulation [and tapered insulation], with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches 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 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.
 - 1) Trim insulation so that the flow of water is not restricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive in accordance with 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** 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.

H. Installation Over Concrete Decks:

1. Install base layer of insulation with [joints staggered not less than **24 inches** in adjacent rows] [end joints staggered not less than **12 inches** 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. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - b. Make joints between adjacent insulation boards not more than **1/4 inch** in width.
 - c. 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**.
 - 1) Trim insulation so that the flow of water is not restricted.
 - d. Fill gaps exceeding **1/4 inch** with insulation.
 - e. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - f. Adhere base layer of insulation to [concrete roof deck] [vapor retarder] in accordance with [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [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) Prime surface of concrete deck with asphalt primer at rate of **3/4 gal./100 sq. ft.**, and allow primer to dry.
 - 2) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F** of equiviscous temperature.
 - 3) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 4) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
2. Install upper layers of insulation [and tapered insulation], with joints of each layer offset not less than **12 inches** from previous layer of insulation.
 - a. Staggered end joints within each layer not less than **24 inches** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches** 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** 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**.

- 1) Trim insulation so that the flow of water is not restricted.
 - f. Fill gaps exceeding **1/4 inch** with insulation.
 - g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive in accordance with [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [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** 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.
- I. Installation Over Cementitious Wood-Fiber Decks:
1. Mechanically fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to cementitious wood fiber decks.
 - a. Fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] in accordance with requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - b. Fasten [sheathing paper] [APP-modified bitumen fiberglass-mat base sheet] [asphalt-coated fiberglass-mat base sheet] to resist specified uplift pressure at corners, perimeter, and field of roof.
 2. Install base layer of insulation with [joints staggered not less than **24 inches** in adjacent rows] [end joints staggered not less than **12 inches** 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** 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**.
 - 1) Trim insulation so that the flow of water is not restricted.
 - e. Fill gaps exceeding **1/4 inch** with insulation.
 - f. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - g. Adhere base layer of insulation to slip sheet in accordance with 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 insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F** of equiviscous temperature.
 - 2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in

- place.
 - 3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- 3. Install upper layers of insulation [**and tapered insulation**], with joints of each layer offset not less than **12 inches** from previous layer of insulation.
 - a. Staggered end joints within each layer not less than **24 inches** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches** 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** 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**.
 - 1) Trim insulation so that the flow of water is not restricted.
 - f. Fill gaps exceeding **1/4 inch** with insulation.
 - g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive in accordance with 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** 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.
- J. Installation Over Lightweight Insulating Concrete Decks:
 - 1. Mechanically fasten vented base sheet to lightweight insulating concrete roof deck, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.
 - a. Fasten vented base sheet in accordance with requirements in [**FM Approvals' RoofNav for specified Windstorm Resistance Classification**] [**SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity**].
 - b. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.
 - 2. Install base layer of insulation with [**joints staggered not less than 24 inches in adjacent rows**] [**end joints staggered not less than 12 inches 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** 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**.
 - 1) Trim insulation so that the flow of water is not restricted.

- e. Fill gaps exceeding **1/4 inch** with insulation.
 - f. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - g. Adhere base layer of insulation to vented base sheet in accordance with **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification]** **[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 insulation in a solid mopping of hot roofing asphalt, applied within plus or minus **25 deg F** of equiviscous temperature.
 - 2) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
3. Install upper layers of insulation[**and tapered insulation**], with joints of each layer offset not less than **12 inches** from previous layer of insulation.
- a. Staggered end joints within each layer not less than **24 inches** in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than **12 inches** 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** 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**.
 - 1) Trim insulation so that the flow of water is not restricted.
 - f. Fill gaps exceeding **1/4 inch** with insulation.
 - g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
 - h. Adhere each layer of insulation to substrate using adhesive in accordance with **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification]** **[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** 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.

3.73.5 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** 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 the flow of water is not restricted.
3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive in accordance with **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification]** **[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** 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 sheathing paper over cover board and immediately beneath roof membrane.

3.93.6 INSTALLATION OF ELD COMPONENTS

- A. Install conductive medium over **[cover board]** **[insulation]** **[and on vertical locations to receive roof membrane]** in accordance with manufacturer's written instructions.
- B. Install sensors, **[wire loop]** **[conductive fabric]**, connections, and accessory items required for complete system in accordance with manufacturer's written instructions.

3.93.7 INSTALLATION OF BUILT-UP ROOFING MEMBRANE

- A. Install roofing in accordance with roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
 1. Base Sheet: **[One]** **[One, installed over sheathing paper]**.
 2. Number of Ply Sheets: **[Two]** **[Three]** **[Four]** **<Insert number>**.
 3. Surfacing: **[Aggregate]** **[Asphalt surfacing or coating]** **[Mineral-granule-surfaced cap sheet]**.
 4. Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel **[and Owner's testing and inspection agency]**.
- C. Where roof slope exceeds **[1/2 inch per 12 inches]** **[3/4 inch per 12 inches]** **<Insert slope>**, install roofing ply sheets parallel with slope.
 1. Backnail roofing ply sheets to **[nailer strips]** **[substrate]** in accordance with roofing system manufacturer's written instructions.
- D. Coordinate installation of roofing, so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
 2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of

- roofing system.
- 3. Remove and discard temporary seals before beginning work on adjoining roofing.
- E. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of **2 inches** and **6 inches**, respectively.
- F. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
 - 1. Mechanically fasten to substrate.
 - 2. Spot or strip mop to substrate with hot roofing asphalt.
 - 3. Adhere to substrate [**in a solid mopping of hot roofing asphalt**] [**using cold-applied asphalt adhesive**] [**using cold-applied polymer-modified asphalt adhesive**].
- G. Install [**three**] [**four**] ply sheets, starting at low point of roof.
 - 1. Align ply sheets without stretching.
 - 2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.
 - a. Shingle in direction to shed water.
 - 3. Extend ply sheets over and terminate above cants.
 - 4. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
 - 5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
 - 6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
 - 7. Install ply sheets without wrinkles, tears, and free from air pockets.
- H. Cap Sheet: Install lapped granulated cap sheet, starting at low point of roofing.
 - 1. Offset laps from laps of preceding ply sheets, and align cap sheet without stretching.
 - 2. Lap in direction to shed water.
 - 3. Extend cap sheet over and terminate above cants.
 - 4. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing system manufacturer.
 - 5. Embed each ply sheet in cold-applied asphalt adhesive applied at a rate required by roofing system manufacturer.
 - 6. Embed each ply in cold-applied polymer-modified asphalt adhesive applied at a rate required by roofing system manufacturer.
 - 7. Install cap sheet without wrinkles, tears, and free from air pockets.
- I. Aggregate Surfacing: After installing and testing roofing, base flashing, and stripping, promptly apply flood coat to roof surface with [**60 lb/100 sq. ft. of hot roofing asphalt**] [**cold-applied polymer-modified asphalt adhesive at rate recommended by roof system manufacturer**]. [**While flood coat is hot and fluid, cast**] [**Cast**] the following average weight of aggregate in a uniform course:
 - 1. Aggregate Weight: [**400 lb/100 sq. ft.**] [**300 lb/100 sq. ft.**].
 - 2. If aggregate surfacing is delayed, promptly apply glaze coat of [**hot roofing asphalt at a rate of 10 lb/100 sq. ft.**] [**cold-applied polymer-modified asphalt adhesive at a rate recommended by roof system manufacturer**].
- J. Glaze-coat roofing surface with hot roofing asphalt applied at a rate of **10 to 15 lb/100 sq. ft.**

3.103.8 INSTALLATION OF FLASHING AND STRIPPING

- A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates in accordance with roofing system manufacturer's written instructions and as follows:
1. Prime substrates with asphalt primer if required by roofing system manufacturer.
 2. Backer Sheet Application: **[Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants]** **[Adhere backer sheet to substrate]** in **[a solid mopping of hot roofing asphalt]** **[cold-applied adhesive]** **[cold-applied polymer-modified adhesive]**.
 3. Flashing Sheet Application, Hot: **[Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer]** **[Torch-apply flashing sheet to substrate]**.
 4. Flashing Sheet Application, Cold: Adhere flashing sheet to substrate in **[cold-applied adhesive]** **[cold-applied polymer-modified adhesive]** **[asphalt roofing cement]** at rate required by roofing manufacturer.
- B. Extend base flashing up walls or parapets a minimum of **8 inches** above built-up roofing and **4 inches** onto field of roofing membrane.
- C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
1. Seal top termination of base flashing **[with a strip of glass-fiber fabric set in asphalt roofing cement]**.
- D. Install liquid flashing system in accordance with manufacturer's recommendations.
1. Extend liquid flashing not less than **3 inches** in all directions from edges of item being flashed.
 2. Embed granules, matching color of roof membrane, into wet compound.
- E. Install stripping in accordance with roofing system manufacturer's written instructions, where metal flanges and edgings are set on roofing membrane.
1. Install flashing sheet stripping in a continuous coating of asphalt roofing cement, in **[a solid mopping of hot roofing asphalt applied at not less than 425 deg F, and extend onto roofing membrane]** **[cold-applied adhesive]** **[cold-applied polymer-modified adhesive]**.
 2. Install flashing sheet stripping by heat welding and extend onto roofing membrane.
 3. Install stripping of not fewer than two roofing ply sheets, setting each ply in a continuous coating of asphalt roofing cement, in **[a solid mopping of hot roofing asphalt]** **[cold-applied adhesive]** **[cold-applied polymer-modified adhesive]**, and extend onto roofing membrane **4 inches** and **6 inches**, respectively.
- F. Roof Drains: Set **[30-by-30-inch]** **<Insert dimensions>** **4-pound** lead flashing in bed of asphaltic adhesive on completed roofing membrane.
1. Cover metal flashing with roofing cap sheet stripping, and extend a minimum of **[4 inches]** **[6 inches]** beyond edge of metal flashing onto field of roofing membrane.
 2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
 3. Install stripping in accordance with roofing manufacturer's written instructions.

3.113.9 INSTALLATION OF COATINGS

- A. Apply coating to **[roofing membrane]** **[and]** **[base flashings]** in accordance with manufacturer's written instructions, by spray, roller, or other suitable application method **[, to provide a dry film thickness of not less than 20 mils]**.

3.123.10 INSTALLATION OF WALKWAYS

- A. Walkway Pads: Install walkway pads, using units of size indicated or, if not indicated, of manufacturer's standard size, in accordance with walkway pad manufacturer's written instructions.
1. Install walkways at following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.
 2. Provide **3-inch** clearance between adjoining pads.
 3. Set walkway pads **[in additional pour coat of hot roofing asphalt] [in cold-applied adhesive] [in cold-applied polymer-modified adhesive]** after sweeping away loose aggregate surfacing.
- B. Walkway Cap-Sheet Strips: Install walkway cap-sheet strips, approximately **36 inches** wide and in lengths not exceeding **10 feet**, over roofing membrane, using same application method as used for roofing cap sheet. **[Install walkway cap-sheet strips before flood coat and aggregate surface is applied.]**
1. Install walkways strips at following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.
 2. Provide **3-inch** clearance between adjoining strips.
- C. Roof-Paver Walkways: Install walkway roof pavers in accordance with roofing manufacturer's written instructions.
1. Install roof paver walkways at following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.
 2. Provide **3-inch** clearance between adjacent roof pavers.

3.133.11 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform the following tests:
 - 1. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - a. Perform tests before overlying construction is placed.
 - b. Flood to an average depth of **[2-1/2 inches]** **<Insert depth>** with a minimum depth of **[1 inch]** **<Insert depth>** and not exceeding a depth of **[4 inches]** **<Insert depth>**. Maintain **2 inches** of clearance from top of base flashing.
 - c. Flood each area for **[24]** **[48]** **[72]** hours.
 - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is the responsibility of the Contractor.
 - e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.
 - 2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.
 - a. Perform tests before overlying construction is placed.
 - b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
 - c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.
 - 3. Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with ASTM D7954/D7954M.
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.
 - 4. Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly in accordance with SPRI/RCI NT-1.
 - a. Perform tests before overlying construction is placed.

- b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of entrapped moisture, if any.
 - 5. Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage [**horizontal membrane scanning platform**] [**membrane electric field vector mapping**] [or] [**vertical membrane scanning**] in accordance with ASTM D8231.
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.
 - 6. High-Voltage Membrane Testing: Testing agency surveys entire [**roof area,**] [**flashings,**] [**and**] [**parapet walls**] to locate discontinuity in the roof membrane using an electrically charged metal "broom head."
 - a. Perform tests before overlying construction is placed.
 - b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.
 - 1) Cost of retesting is Contractor's responsibility.
 - c. Testing agency to prepare survey report indicating locations of initial discontinuities, if any.
- C. Test Cuts: Remove test specimens to evaluate problems observed during quality-assurance inspections of roofing system as follows:
 - 1. Determine approximate quantities of components within roofing system in accordance with ASTM D3617/D3617M.
 - 2. Examine test specimens for interply voids in accordance with ASTM D3617/D3617M and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
 - 3. Repair areas where test cuts were made in accordance with roofing manufacturer's written instructions.
- D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
 - 1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- F. Roofing system will be considered defective if it does not pass tests and inspections.
 - 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.143.12 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period.
 - 1. When remaining construction does not affect or endanger roofing, 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 components that do not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.153.13 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: <Insert name of Owner>.
 - 2. Owner Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Building Address: <Insert address>.
 - 5. Area of Work: <Insert information>.
 - 6. Acceptance Date: _____.
 - 7. Warranty Period: <Insert time>.
 - 8. Expiration Date: _____.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert mph>;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals,

whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____,
_____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075113

SECTION 076100 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic-coated steel sheet.
2. Aluminum sheet.
- ~~3. Copper sheet.~~
- ~~4. Zinc-tin alloy-coated copper sheet.~~
- ~~5-3.~~ Stainless steel sheet.
- ~~6. Copper-clad stainless steel sheet.~~
- ~~7. Zinc sheet.~~
- ~~8. Titanium sheet.~~
- ~~9. Underlayment materials.~~
- ~~10-4.~~ Fasteners.
- ~~11-5.~~ Sealant tape.
- ~~12-6.~~ Elastomeric sealant.
- ~~13-7.~~ Butyl sealant.

~~B. Related Requirements:~~

- ~~1. Section 061000 "Rough Carpentry" for wood battens required for batten-seam sheet metal roofing if not specified in this Section.~~
- ~~2. Section <Insert Section number> "<Insert Section title>" for roll-formed metal roof panels.~~
- ~~3. Section 074293 "Soffit Panels" for manufactured metal panels used in horizontal soffit applications.~~
- ~~4. Section 076200 "Sheet Metal Flashing and Trim" for [gutters] [downspouts] [fasciae] and flashings that are not part of sheet metal roofing.~~
- ~~5. Section 077100 "Roof Specialties" for manufactured [fasciae] [and] [copings] that are not part of sheet metal roofing.~~
- ~~6. Section 077200 "Roof Accessories" for manufactured roof accessories.~~
- ~~7. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.~~
- ~~8. Section 079200 "Joint Sealants" for field-applied sealants adjoining sheet metal roofing and not otherwise specified in this Section.~~

1.2 COORDINATION

- A. Coordinate sheet metal roofing layout and seams with sizes and locations of roof curbs, equipment supports, equipment provided, and roof penetrations.
- B. Coordinate sheet metal roofing installation with rain drainage work, flashing, trim, and construction of roofing substrate, parapets, walls, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
 - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review structural loading limitations of substrates during and after roofing installation.
 - 3. Review insulation, air barrier, vapor retarder, and underlayment requirements.
 - 4. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affect sheet metal roofing.
 - 5. Review requirements for insurance and certificates if applicable.
 - 6. Review roof observation and repair procedures after sheet metal roofing installation.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Metallic-coated steel sheet.
 - 2. Aluminum sheet.
 - 3. Copper sheet.
 - 4. Zinc-tin alloy-coated copper sheet.
 - 5. Stainless steel sheet.
 - 6. Copper-clad stainless steel sheet.
 - 7. Zinc sheet.
 - 8. Titanium sheet.
 - 9. Underlayment materials
 - 10. Fasteners.
 - 11. Sealant tape.
 - 12. Elastomeric sealant.
 - 13. Butyl sealant.
- 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:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail fabrication and panel installation layouts, expansion joint locations, points of fixity, and keyed details. Distinguish between shop- and field-assembled Work.
 - 3. Include details for forming, including seams and dimensions.
 - 4. Include details for joining and securing, including layout and spacing of fasteners, cleats, and other attachments. Include pattern of seams.
 - 5. Include details of expansion joints, including showing direction of expansion and contraction from points of fixity.
 - 6. Include details of roof penetrations.
 - 7. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, corners, flashings, and counterflashings.
 - 8. Include details of special conditions.

9. Include details of connections to adjoining work.
 10. Detail the following accessory items, at scale of not less than [1-1/2 inches per 12 inches] [3 inches per 12 inches] <Insert scale>:
 - a. Flashing and trim.
 - b. Roof curbs.
- D. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
- E. Samples for Initial Selection: For each type of sheet metal with factory-applied finishes.
1. Include Samples of trim and accessories involving finish or color selection.
- F. Samples for Verification: For each type of exposed finish.
1. Sheet Metal Roofing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, [battens,] and other attachments.
 2. Trim and Metal Closures: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 3. Other Accessories: 12-inch-long Samples for each type of other accessory.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:
1. Sheet metal roofing, seam locations, and attachments.
 2. Roof hatches.
 3. Equipment supports, pipe supports, and penetrations.
 4. Lighting fixtures and cable runs.
 5. Snow guards.
 6. Items mounted on roof curbs.
 7. Details for penetrations.
- B. Qualification Data: For [Installer] [fabricator].
1. Include listing of completed projects of comparable scale of this Project, including name, address, telephone, and contact person for Architect, and name, address, telephone number, and contact person for building Owner.
- C. Evaluation Reports: For self-adhering, high-temperature sheet underlayment, from ICC-ES.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing sheet metals and accessories to include in maintenance manuals.
- B. Special warranties.

1.7 QUALITY ASSURANCE

- A. Sheet Metal Roofing Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal roofing similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof area and eave as indicated on Drawings, including[, **underlayment**,] attachments, and accessories.
 - a. Size: Approximately [**12 feet long by 6 feet**] [**48 inches square**] [**12 feet square**] <Insert dimension(s)>.
 - b. Include [**each type of exposed seam and seam termination**] [**fascia**] [**soffit**] [**and**] [**gable end and rake**] <Insert mockup item>.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store sheet metal roofing materials away from uncured concrete and masonry.
 - 2. Protect stored sheet metal roofing materials from contact with water.
- B. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal roofing installation.

1.9 WARRANTY

- A. Special Warranty: Warranty form at end of this Section in which Installer agrees to repair or replace components of sheet metal roofing that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including, but not limited to, rupturing, cracking, or puncturing.
 - b. Wrinkling or buckling.
 - c. Loose parts.
 - d. Failure to remain weathertight, including uncontrolled water leakage.
 - e. Deterioration of metals, metal finishes, and other materials beyond normal weathering, including nonuniformity of color or finish.
 - f. Galvanic action between sheet metal roofing and dissimilar materials.
 - 2. Warranty Period: [**Two**] [**Five**] <Insert number> years from date of Substantial Completion.

- B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: [20] [10] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Sheet metal roofing system, including, but not limited to, metal roof panels, cleats, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim [, battens], underlayment, and accessories, is to comply with requirements without failure due to defective manufacture, fabrication, or installation, or due to other defects in construction. Sheet metal roofing is to remain watertight.
- B. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or indicated on Drawings.
- C. Copper Roofing Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are specified or indicated on Drawings.
- D. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [64] [32] or initial SRI not less than [82] [39] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- F. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- G. Solar Reflectance Index (SRI): Three-year-aged SRI not less than [64] [15] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- H. Solar Reflectance Index: Not less than [78] [29] when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- I. Energy Performance: Provide sheet metal roofing according to one of the following when tested in accordance with ANSI/CRRC S100:
1. Three-year, aged, solar reflectance of not less than [0.63] [0.55] <Insert value> and emissivity of not less than [0.75] <Insert value>.
 2. Three-year, aged, Solar Reflectance Index (SRI) of not less than [75] [64] <Insert value> when calculated in accordance with ASTM E1980.

- J. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
1. Temperature Change: **[120 deg F, ambient; 180 deg F, material surfaces]** <Insert temperature change>.

2.2 ROOFING SHEET METALS

- A. ~~Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.~~
- B. ~~Metallic-Coated Steel Sheet: Provide [zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation] [or] [aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40]; with [smooth, flat] [embossed] surface; prepainted by coil-coating process to comply with ASTM A755/A755M.~~
1. ~~Thickness: Nominal [0.022 inch] [0.028 inch] <Insert dimension> unless otherwise indicated.~~
- a. ~~Batten Caps: Nominal 0.028 inch thick.~~
2. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
3. ~~Exposed Coil-Coated Finish:~~
- a. ~~Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
- b. ~~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. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
- c. ~~Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
- d. ~~Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
- e. ~~FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
- f. ~~Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.~~
4. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~
5. ~~Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.~~

- C. ~~Aluminum Sheet: ASTM B209 alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with [smooth, flat] [embossed] surface.~~
1. ~~Thickness: [0.032 inch] [0.040 inch] unless otherwise indicated.~~
 - a. ~~Batten Caps: 0.050 inch thick.~~
 2. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
 3. ~~As-Milled Finish: [Mill] [One-side bright mill] [Standard one-side bright] [Standard two-side bright].~~
 4. ~~Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.~~
 5. ~~Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.~~
 6. ~~Exposed Coil-Coated Finish:~~
 - a. ~~Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - b. ~~Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - c. ~~Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - d. ~~Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - e. ~~FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - f. ~~Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.~~
 7. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~
 8. ~~Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.~~
- D. ~~Stainless Steel Sheet: ASTM A240/A240M, [Type 304] [Type 316], dead soft, fully annealed; with [smooth, flat] [embossed] surface.~~
1. ~~Thickness: [0.0156 inch] [0.0188 inch] unless otherwise indicated.~~
 - a. ~~Batten Caps: 0.0188 inch thick.~~
 2. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value>~~

percent.

3. ~~Finish: [ASTM A480/A480M, No. 2D (dull, cold rolled)] [ASTM A480/A480M, No. 2B (bright, cold rolled)] [ASTM A480/A480M, No. 3 (coarse, polished directional satin)] [ASTM A480/A480M, No. 4 (polished directional satin)] <Insert finish>.~~

- 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. Run grain of directional finishes with long dimension of each piece.~~
- c. ~~When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.~~

2.3 ~~UNDERLAYMENT MATERIALS~~

- A. ~~Felts: ASTM D226/D226M, [Type II (No. 30)] [Type I (No. 15)], asphalt-saturated organic felts.~~
- B. ~~Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.~~

2.42.2 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners[, **solder**], protective coatings, sealants, and other miscellaneous items as required for complete roofing system and as recommended by primary sheet metal manufacturer unless otherwise indicated.
- B. Wood Battens: Lumber in accordance with requirements for nailers for roofing in Section 061000 "Rough Carpentry."
- C. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. General:
 - a. Exposed Fasteners: Heads matching color of sheet metal roofing, using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of roofing.
 - b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed; with hex-washer head.
 - c. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
 - 3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 4. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 - 5. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 - 6. Fasteners for Zinc Sheet: Series 300 stainless steel[**or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M**].
 - 7. Fasteners for Titanium Sheet: Titanium or Series 300 stainless steel.
- D. Solder:
 - 1. For Zinc-Coated (Galvanized) Steel: ASTM B32, [**Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent**

- tin and 40 percent lead] [with maximum lead content of 0.2 percent].**
2. For Copper or Copper-Clad Stainless Steel: ASTM B32, **[Grade Sn50, 50 percent tin and 50 percent lead] [with maximum lead content of 0.2 percent].**
 3. For Stainless Steel: ASTM B32, **[Grade Sn60] [Grade Sn96]**, with acid flux of type recommended by stainless steel sheet manufacturer.
 4. For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
 5. For Zinc: ASTM B32, **[40 percent tin and 60 percent lead with low antimony,] [with maximum lead content of 0.2 percent,]** as recommended by zinc manufacturer.
- E. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch** wide and **1/8 inch** thick.
- F. Elastomeric Sealant: ASTM C920, elastomeric **[polyurethane] [polysulfide] [silicone]** polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.
- G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187.
- I. Underlayment Adhesive:
1. Cold-Applied Asphalt Adhesive: ASTM D3019, Type III, asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
 2. Cold-Applied Polymer-Modified Asphalt Adhesive: Underlayment manufacturer's standard solvent-and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with underlayment.
 3. Adhesives and sealants 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."
 4. Adhesives and sealants 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."
 5. Adhesives and sealants 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 6. Adhesives and sealants 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."
 7. Adhesives and sealants 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.52.3 ACCESSORIES

- A. Sheet Metal Accessories: Provide components required for complete sheet metal roofing assembly, including trim, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal

roofing unless otherwise indicated.

1. Cleats: Intermittent and continuous attachment devices for mechanically seaming into joints and formed from the following materials and thicknesses unless otherwise indicated:
 - a. Metallic-Coated Steel or Aluminum Roofing: [~~0.0250-inch~~] <Insert dimension> thick stainless steel.
 - b. Copper or Zinc-Tin Alloy-Coated Copper Roofing: [~~16-inch~~] [~~20-inch~~] <Insert weight (thickness)> thick copper sheet.
 - c. Stainless Steel or Titanium Roofing: [~~0.0250-inch~~] <Insert dimension> thick stainless steel.
 - d. Copper-Clad Stainless Steel Roofing: [~~0.024-inch~~] <Insert dimension> thick, copper-clad stainless steel.
 - e. Zinc Roofing: Manufacturer's preformed stainless steel cleats.
 2. Expansion-Type Cleats: Cleats of a design that allows longitudinal movement of roof panels without stressing panel seams; of same material as other cleats.
 3. Backing Plates: Plates at roofing splices, fabricated from material recommended by SMACNA's "Architectural Sheet Metal Manual."
 4. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum ~~1-inch~~ thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where necessary to ensure weathertight construction.
 5. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum [~~0.018 inch~~] <Insert dimension> thick.
- B. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
- C. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness [~~matching the sheet metal roofing~~] <Insert dimension>; with bottom of skirt profiled to match roof panel and seam profiles; with weatherproof top box and integral full-length cricket.
1. Fabricate curb subframing of nominal [~~0.062-inch~~] <Insert dimension> thick, angle-, C- or Z-shaped, galvanized-steel or stainless steel sheet.
 2. Fabricate curb and subframing to withstand indicated loads of size and height indicated.
 3. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
 4. Insulate curbs with [~~1-inch~~] <Insert dimension> thick, rigid insulation.
 5. Provide treated wood nailers at tops of curbs.

2.62.4 FABRICATION

- A. Custom-Fabricated Sheet Metal Roofing: Comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation. Fabricate sheet metal roofing and accessories in shop to greatest extent possible.
- B. Flat-Seam Sheet Metal Roofing: Form flat-seam panels from metal sheets [~~20 by 28 inches~~] <Insert dimensions> with ~~1/2-inch~~ notched and folded edges.
- C. Standing-Seam Sheet Metal Roofing: Form standing-seam panels with finished seam height [~~of 1 inch~~] [~~of 1-1/2 inches~~] [~~as indicated~~] <Insert dimension>.
- D. Batten-Seam Sheet Metal Roofing: Form batten-seam panels with edges turned up [~~2-1/8 inches~~] [~~as indicated~~] <Insert dimension> and with ~~1/2-inch~~ flange turned toward center of pan.

- E. Horizontal-Seam (Bermuda-Type) Sheet Metal Roofing: Form horizontal-seam (Bermuda-type) panels with upper edges of lower panels turned up and extending **1/2 inch** above continuous horizontal steps in substrate.
- F. Fabrication Tolerances: **[Fabricate sheet metal roofing that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.]**
[Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Metal Roof Installation Manual."]
- G. Form exposed sheet metal work to fit substrates with little oil canning; free of buckling and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 1. Lay out sheet metal roofing, so transverse seams, if required, are made in direction of flow, with higher panels overlapping lower panels.
 - 2. Offset transverse seams from each other **[12 inches]** ~~<Insert dimension>~~ **inches** minimum.
 - 3. Fold and cleat eaves and transverse seams in shop.
 - 4. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements indicated on Drawings and as required for leakproof construction.
- H. Built-in Gutters (Integral Gutters): Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
 - 1. Fabricate in minimum **96-inch** long sections.
 - 2. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
 - 3. Fabricate gutters with built-in expansion joints.
- I. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- J. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant in accordance with SMACNA's "Architectural Sheet Metal Manual."
- K. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item required. Obtain field measurements for accurate fit before shop fabrication.
 - 1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 2. Seams: Fabricate nonmoving seams with flat-lock seams. **[Tin edges to be seamed, form seams, and solder.] [Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.] [Rivet joints where necessary for strength.]**
 - 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant.
 - 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces of accessories exposed to view.
 - 5. Fabricate cleats and attachment devices of sizes recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

- L. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances required for finished roofing installation.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for drainage, flashings, and penetrations through sheet metal roofing.
 - 3. Verify that air- or water-resistant 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 sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Lay out panel arrangement, and [nail battens to wood sheathing] [screw battens to wood sheathing] [screw battens to metal deck] before installation of sheet metal roofing.
 - 1. Space fasteners not more than [18 inches] <Insert dimension> o.c.

3.3 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal roofing.
 - 1. Install in shingle fashion to shed water, with lapped joints of not less than 4 inches.
 - 2. Apply from eave to ridge.
 - 3. Apply on roof not covered by self-adhering sheet underlayment.
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
 - 1. Apply from eave to ridge.
 - 2. Apply on roof not covered by self-adhering sheet underlayment.
 - 3. Lap horizontal joints not less than 4 inches.
 - 4. Lap end joints not less than 12 inches.

C. Self-Adhering High-Temperature Sheet Underlayment:

1. Install self-adhering high-temperature sheet underlayment, wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than **6 inches** staggered **24 inches** between courses.
5. Overlap side edges not less than **3-1/2 inches**.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days of installation.
8. Install self-adhering high-temperature underlayment at the following locations:
 - a. Over entire roof.
 - b. Roof perimeter for a distance up from eaves of [**24 inches**] [**36 inches**] <Insert dimension> beyond interior wall line.
 - c. Valleys, from lowest to highest point, for a distance on each side of [**18 inches**] <Insert dimension>.
 - d. Rake edges for a distance of [**18 inches**] <Insert dimension>.
 - e. Hips and ridges for a distance on each side of [**12 inches**] <Insert dimension>.
 - f. Roof-to-wall intersections for a distance from wall of [**18 inches**] <Insert dimension>.
 - g. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of [**18 inches**] <Insert dimension>.
 - h. Below entire area of integral gutters, up from eaves a minimum of [**36 inches**] <Insert dimension> beyond interior wall line, but not less than [**12 inches**] <Insert dimension> up from ridge side of gutter.
 - i. Directional transitions for a distance of [**12 inches**] <Insert dimension> in each direction.

D. Install slip sheet, wrinkle free, [**over underlayment**] [**directly on substrate**] <Insert requirement> before installing sheet metal roofing and related flashing.

1. Install in shingle fashion to shed water, with lapped joints of not less than **4 inches**.

E. Install ventilation mat over underlayment before installing sheet metal roofing and related flashing.

F. Install flashings to cover [**underlayment**] [**slip sheet**] [**ventilation mat**] in accordance with requirements in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION, GENERAL

A. Install sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners[, **solder**], protective coatings, separators, sealants, and other miscellaneous items as required for complete roofing system.
2. Install sheet metal roofing true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**] [**welds**] [**sealant**].
3. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Do not field cut sheet metal roofing by torch.
5. Provide metal closures at [**peaks**] [**rake edges**] [**rake walls**] [**eaves**] [**and**] each side of ridge [**and hip**] caps.

6. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
 7. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
 8. Install ridge [**and hip**] caps as sheet metal roofing work proceeds.
 9. Lap metal flashing over sheet metal roofing to direct moisture to run over and off roofing.
 10. Do not use graphite pencils to mark metal surfaces.
- B. Thermal Movement: Rigidly fasten metal roof panels to structure at only one location for each panel.
1. Allow remainder of panel to move freely for thermal expansion and contraction.
 2. Point of Fixity: Fasten each panel along a single common line of fixing located at [**eave**] [**ridge**] [**center of panel length**] [**locations indicated on Drawings**] <Insert location>.
 3. Avoid attaching accessories through roof panels in manner that inhibits thermal movement.
- C. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws**] [**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**] <Insert size requirement>.
- D. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended in SMACNA's "Architectural Sheet Metal Manual."
1. Coat concealed side of [**uncoated-aluminum**] [**and**] [**stainless steel**] sheet metal roofing with bituminous coating where roofing contacts wood, ferrous metal, or cementitious construction.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Fasciae:
1. Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws.
 2. Flash and seal sheet metal roofing with closure strips where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.5 INSTALLATION OF CUSTOM-FABRICATED SHEET METAL ROOFING

- A. Install sheet metal roofing system with lines and corners of exposed units true and accurate.
1. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering metal temper and reflectivity.
 2. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 3. Fold back sheet metal to form hem on concealed side of exposed edges unless otherwise indicated.
- B. Install cleats to hold sheet metal roofing panels in position.
1. Attach each cleat with at least two fasteners to prevent rotation.
 2. Space cleats not more than [**12 inches**] <Insert dimension> o.c.
 3. Bend tabs over fastener head.

4. Provide expansion-type cleats for roof panels that exceed **30 feet** in length.
- C. Seal joints as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.
 1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than **1 inch** into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between **40 and 70 deg F**, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - e. Do not install sealant-type joints at temperatures below **40 deg F**.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
 1. Pre-tin edges of sheets with solder to a width of **1-1/2 inches**; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 2. Do not solder **[metallic-coated steel]** **[aluminum]** **[and]** **[titanium]** sheet.
 3. Do not pre-tin zinc-tin alloy-coated copper.
 4. Do not use torches for soldering.
 5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
 6. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
 8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.
- E. Rivets: Rivet joints in **[uncoated aluminum]** **[zinc]** where necessary for strength.
- F. Flat-Seam Roofing:
 1. Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
 2. After panels are in place, mallet seams tight and solder.
 3. Attach roofing panels with cleats spaced not more than **[24 inches]** **<Insert dimension>** o.c. Lock and solder panels to base flashing.
 4. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at **[12-inch]** **<Insert dimension>** o.c. spacing. Lock panels to edge flashing and **[solder]** **[apply sealant]**.
- G. Standing-Seam Roofing:
 1. Attach standing-seam metal panels to substrate with double-fastened cleats spaced at **[12 inches]** **<Insert dimension>** o.c.

2. Install panels reaching from eave to ridge before moving to adjacent panels.
 - a. Where transverse joints are required, stagger joints in adjacent panels not less than **48 inches**.
 3. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel.
 4. Lock standing seams by folding over twice, so cleat and panel edges are completely engaged.
 5. Lock each panel to panel below with **[soldered]** **[sealed]** transverse seam.
 6. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
 7. Loose-lock panels at eave edges to continuous edge flashing exposed **24 inches** from roof edge.
 - a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at **[12-inch]** **<Insert dimension>** o.c. spacing.
 - b. Lock panels to edge flashing.
 8. **[Leave seams upright]** **[Fold over seams]** after locking at ridges and hips.
- H. Batten-Seam Roofing:
1. Attach batten-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
 2. Hold cleats in place with battens, and fold edges of cleats over to hold panels.
 3. After panels are in place and before batten cap is installed, apply continuous bead of sealant to top of upturned flanges of each panel.
 4. Install batten cap covering batten and panel edges, and fold batten cap and panel together, so batten cap and panel edges are completely engaged in seams.
 5. Hook each panel to panel below with **[soldered]** **[sealed]** transverse seam.
 6. Splay upturned edges of panels at a slightly obtuse angle, so pan-bottom width is slightly narrower than space between battens, to provide expansion capability.
 7. Close batten ends with metal closures. Fold together with panel edges and end of batten cap.
 8. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
 9. Loose-lock panels at eave edges to continuous-edge flashing exposed **24 inches** from roof edge.
 - a. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at **[12-inch]** **<Insert dimension>** o.c. spacing.
 - b. Lock panels to edge flashing.
- I. Horizontal-Seam (Bermuda-Type) Roofing:
1. Attach horizontal-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge.
 2. Attach cleats along continuous horizontal steps in substrate, with cleats at **[8-inch]** **<Insert dimension>** o.c. spacing.
 3. Lock lower edge of each panel to turned-up upper edge of panel below, folding seam over to engage cleat and panel edges.
 4. After first fold, mallet seams against substrate, leaving joint slightly angled over lower panel to form drip.
 5. Hook end of each panel to adjacent panel with **[soldered]** **[sealed]** cross seam.
 6. Hook panel at eave edge to continuous cleat.
 7. Join ridges and hips with a standing seam, and **[leave seams upright]** **[fold over seams]** after locking.
- J. Built-in Gutters:
1. Anchor back edge of gutter with continuous cleat.
 2. Provide expansion joints at locations indicated on Drawings, but not less than **50 feet** on center.

3. Join gutter sections with soldered joints.
 - a. Join sections with lapped joints sealed with sealant where required for expansion.
4. Provide for thermal expansion.
5. Slope gutters to drainage points.
6. Provide end closures and seal watertight with sealant.
7. Install self-adhering, high-temperature sheet underlayment inside built-in gutter as indicated on Drawings.
 - a. Extend self-adhering, high-temperature sheet underlayment to eave drip edges and beneath roof underlayment.
 - b. Lap edges **2 inches**.
 - c. Lap ends **4 inches**.

3.6 INSTALLATION OF ACCESSORIES

- A. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion.
 1. Coordinate installation with flashings and other components.
 2. Install components required for complete sheet metal roofing assembly, including trim, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
 3. Install accessories integral to sheet metal roofing that are specified in Section 076200 "Sheet Metal Flashing and Trim" to comply with that Section's requirements.
- B. Flashing and Trim: Comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual."
 1. Provide concealed fasteners where possible, and install units true to line, levels, and slopes.
 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
 3. Install flashing and trim as required to seal against weather and to provide finished appearance, including, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
 4. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual" and on Drawings.
 5. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 6. Install sheet metal flashing and trim to fit substrates, and to result in waterproof and weather-resistant performance.
 7. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
 - a. Space expansion joints at maximum of **10 feet** with no joints within **24 inches** of corner or intersection.
 - b. Form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, and filled with butyl sealant concealed within joints.
 - c. Use lapped expansion joints only where indicated on Drawings.
- C. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended in SMACNA's "Architectural Sheet Metal Manual."
- D. Roof Curbs: Install flashing around bases where curbs meet sheet metal roofing.

3.7 INSTALLATION TOLERANCES

- A. Installation Tolerances: [Shim and align sheet metal roofing within installed tolerance of **1/4 inch in 20 feet** on slope and location lines indicated on Drawings and within **1/8-inch** offset of adjoining faces and of alignment of matching profiles.] [Shim and align sheet metal roofing within installed tolerances specified in MCA's "Metal Roof Installation Manual."]

3.8 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer.
- C. Clean and neutralize flux materials. Clean off excess solder.
- D. Clean off excess sealants.

3.9 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Prohibit traffic of any kind on installed sheet metal roofing.
- C. Maintain sheet metal roofing in clean condition during construction.
- D. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

3.10 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS <Insert name> of <Insert address>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: <Insert name>.
 - 2. Owner's Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Building's Address: <Insert address>.
 - 5. Area of Work: <Insert information>.
 - 6. Acceptance Date: <Insert date>.
 - 7. Warranty Period: <Insert time>.
 - 8. Expiration Date: <Insert date>.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said

work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. Lightning;
 - b. Peak gust wind speed exceeding <Insert mph>;
 - c. Fire;
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. Faulty construction of parapet walls, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. Vapor condensation on bottom of roofing; and
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature>.
2. Name: <Insert name>.
3. Title: <Insert title>.

END OF SECTION 076100

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof-drainage sheet metal fabrications.
2. Low-slope roof sheet metal fabrications.
3. Steep-slope roof sheet metal fabrications.
4. Wall sheet metal fabrications.
5. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section <Insert Section number> "<Insert Section title>" for [materials and] installation of manufactured sheet metal through-wall flashing and trim integral with masonry.
3. Section <Insert Section number> "<Insert Section title>" for [materials and] installation of sheet metal flashing and trim integral with roofing.
4. Section <Insert Section number> "<Insert Section title>" for sheet metal flashing and trim integral with metal wall panels.
5. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
6. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Section 079513.13 "Interior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
8. Section 079513.16 "Exterior Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
9. Section 079513.19 "Parking Deck Expansion Joint Cover Assemblies" for manufactured expansion-joint cover assemblies subject to vehicular traffic.

1.2 COORDINATION

- A.** Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B.** Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

- A.** Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Roof-drainage sheet metal fabrications.
2. Low-slope roof sheet metal fabrications.
3. Steep-slope roof sheet metal fabrications.
4. Wall sheet metal fabrications.
5. Miscellaneous sheet metal fabrications.

B. Product Data Submittals:

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.
4. Epoxy seam sealer.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail formed flashing and trim at scale of not less than [1-1/2 inches per 12 inches] [3 inches per 12 inches] <Insert scale>.

E. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

- F. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- G. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: **12 inches** long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: **12 inches** long and in required profile. Include fasteners and other exposed accessories.
 - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is **[ANSI/SPRI/FM 4435/ES-1 tested]** **[and]** **[FM Approvals approved]**.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For copings and roof edge flashing, from **[an agency acceptable to authority having jurisdiction]** **[ICC-ES]** **<Insert evaluation agency>** showing compliance with ANSI/SPRI/FM 4435/ES-1.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested **[and FM Approvals approved]**, shop is to be listed as able to fabricate required details as tested and approved.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof **[edge]** **[eave]**, including **[built-in gutter]** **[fascia]** **[fascia trim]** **[apron flashing]** **<Insert item>**, approximately **[10 feet]** **<Insert dimension>** long, including supporting construction cleats, seams, attachments, **[underlayment]**, and accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: [20] [10] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with [NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"] [and] [SMACNA's "Architectural Sheet Metal Manual"] requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. SPRI Wind Design Standard: Manufacture and install [copings] [roof edge flashings] tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 1. Design Pressure: [As indicated on Drawings] <Insert design pressure>.

- E. FM Approvals Listing: Manufacture and install [copings] [roof edge flashings] that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, [Class 1-60] [Class 1-75] [Class 1-90] [Class 1-105] [Class 1-120] <Insert class>. Identify materials with name of fabricator and design approved by FM Approvals.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: [120 deg F, ambient; 180 deg F, material surfaces] <Insert temperature change>.

2.2 SHEET METALS

- A. ~~Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.~~
- B. ~~Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with [smooth, flat] [embossed] surface.~~
 - 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
 - 2. ~~As-Milled Finish: [Mill] [One-side bright mill] [Standard one-side bright] [Standard two-side bright].~~
 - 3. ~~Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.~~
 - 4. ~~Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.~~
 - 5. ~~Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.~~
 - 6. ~~Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.~~
 - a. ~~Color: [Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.~~
 - b. ~~Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.~~
- 7. ~~Exposed Coil-Coated Finish:~~
 - a. ~~Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - b. ~~Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - c. ~~Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - d. ~~Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare,~~

- pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions ~~[for seacoast and severe environments]~~.
- e. ~~FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - f. ~~Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat, with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.~~
8. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~
9. ~~Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.~~
- C. ~~Stainless Steel Sheet: ASTM A240/A240M, [Type 304] [Type 316], dead soft, fully annealed; with [smooth, flat] [embossed] surface.~~
- 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
 - 2. ~~Finish: [ASTM A480/A480M, No. 2D (dull, cold rolled)] [ASTM A480/A480M, No. 2B (bright, cold rolled)] [ASTM A480/A480M, No. 3 (coarse, polished directional satin)] [ASTM A480/A480M, No. 4 (polished directional satin)] <Insert finish>.~~
 - 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 grain of directional finishes with long dimension of each piece.~~
 - 2) ~~When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.~~
- D. ~~Metallic-Coated Steel Sheet: Provide [zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation] [or] [aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40]; prepainted by coil-coating process to comply with ASTM A755/A755M.~~
- 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
 - 2. ~~Surface: [Smooth, flat] [Embossed] [and mill phosphatized for field painting] [and with manufacturer's standard clear acrylic coating on both sides].~~
 - 3. ~~Exposed Coil-Coated Finish:~~
 - a. ~~Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - b. ~~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. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~
 - c. ~~Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].~~

environments]-

- d. **—** Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - e. **—** FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether (FEVE) resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 - f. **—** Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than **0.2 mil** for primer and **0.8 mil** for topcoat.
- 4. **—** Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.
 - 5. **—** Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil**.

E. **—** Lead Sheet: ASTM B749 lead sheet.

2.3 **—** UNDERLAYMENT MATERIALS

A. **—** Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

B. **—** Slip Sheet: Rosin-sized building paper, **3 lb/100 sq. ft.** minimum.

2.4 **—** MISCELLANEOUS MATERIALS

A. **—** Provide materials and types of fasteners **[, solder]**, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal **[or manufactured item]** unless otherwise indicated.

B. **—** Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal **[or manufactured item]**.

1. **—** General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. **—** Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.

b. **—** Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

c. **—** Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. **—** Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.

3. **—** Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

4. **—** Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

5. **—** Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

6. **—** Fasteners for Zinc Sheet: Series 300 stainless steel **[or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M]**.

C. — Solder:

1. — For Copper or Copper-Clad Stainless Steel: ASTM B32, [~~Grade Sn50, 50 percent tin and 50 percent lead~~] [~~with maximum lead content of 0.2 percent~~].
2. — For Stainless Steel: ASTM B32, [~~Grade Sn60~~] [~~Grade Sn96~~], with acid flux of type recommended by stainless steel sheet manufacturer.
3. — For Zinc-Tin Alloy-Coated Copper: ASTM B32, 100 percent tin, with maximum lead content of 0.2 percent, as recommended by sheet metal manufacturer.
4. — For Zinc-Coated (Galvanized) Steel: ASTM B32, [~~Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead~~] [~~with maximum lead content of 0.2 percent~~].
5. — For Zinc: ASTM B32, [~~40 percent tin and 60 percent lead with low antimony,~~] [~~with maximum lead content of 0.2 percent,~~] as recommended by zinc manufacturer.

D. — Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch** wide and **1/8 inch** thick.

E. — Elastomeric Sealant: ASTM C920, elastomeric [~~polyurethane~~] [~~polysulfide~~] [~~silicone~~] polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. — Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. — Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. — Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

I. — Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.52.2 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of **1/4 inch in 20 feet** on slope and location lines indicated on Drawings and within **1/8-inch** offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard [**and by FM Global Property Loss Prevention Data Sheet 1-49**] for application, but not less than thickness of metal being secured.
- G. Seams:
 - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. [**Rivet joints where necessary for strength.**]
 - 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. [**Rivet joints where necessary for strength.**]
- H. Do not use graphite pencils to mark metal surfaces.

2.62.3 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters:
 - 1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
 - 2. Fabricate in minimum **96-inch** long sections.
 - 3. Furnish flat-stock gutter brackets and [~~flat-stock~~] [**twisted**] gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than [**twice the gutter thickness**] [**dimension indicated on Drawings**] <Insert dimension>.
 - 4. Fabricate expansion joints, expansion-joint covers, [**gutter bead reinforcing bars,**] and gutter accessories from same metal as gutters. [**Shop fabricate interior and exterior corners.**]
 - 5. Gutter Profile: [**Style A**] [**Style B**] [**Style C**] [**Style D**] [**Style E**] [**Style F**] [**Style G**] [**Style H**] [**Style I**] [**Style J**] [**Style K**] [**Style L**] in accordance with cited sheet metal standard.
 - 6. Expansion Joints: [**Lap type**] [**Butt type**] [**Butt type with cover plate**] [**Built in**].
 - 7. Accessories: [**Continuous, removable leaf screen with sheet metal frame and hardware cloth screen**] [**Wire-ball downspout strainer**] [**Valley baffles**].
 - 8. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
 - a. Copper: [**16 oz./sq. ft.**] <Insert value>.
 - b. Aluminum: [**0.032 inch**] <Insert dimension> thick.
 - c. Stainless Steel: [**0.0156 inch**] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft.**] <Insert value>.
 - e. Galvanized Steel: [**0.022 inch**] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch**] <Insert dimension> thick.

- g. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
9. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
- a. Copper: [16 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.040 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 - g. Zinc: [0.039 inch] [0.048 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
10. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
- a. Copper: [20 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.050 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0250 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [20 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.034 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.034 inch] <Insert dimension> thick.
 - g. Zinc: [0.048 inch] [0.059 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.027 inch] <Insert dimension> thick.
11. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
- a. Copper: [24 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.063 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0313 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [24 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.040 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.040 inch] <Insert dimension> thick.
12. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:
- a. Copper: [24 oz./sq. ft.] <Insert value>.
 - b. Stainless Steel: [0.0375 inch] <Insert dimension> thick.
 - c. Zinc-Tin Alloy-Coated Copper: [25 oz./sq. ft.] <Insert value>.
 - d. Galvanized Steel: [0.052 inch] <Insert dimension> thick.
 - e. Aluminum-Zinc Alloy-Coated Steel: [0.052 inch] <Insert dimension> thick.

B. Built-in Gutters:

- 1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
- 2. Fabricate in minimum ~~96-inch~~ long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
- 3. Fabricate gutters with built-in expansion joints[and gutter-end expansion joints at walls].

4. Accessories: [Continuous, removable leaf screen with sheet metal frame and hardware cloth screen] [Bronze wire-ball downspout strainer] [Wire-ball downspout strainer].
5. Fabricate from the following materials:
 - a. Copper: [16 oz./sq. ft.] <Insert value>.
 - b. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 - c. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - d. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - e. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- C. Downspouts: Fabricate [round] [rectangular] [open-face] downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from [same material as downspouts and anchors] <Insert material>. [Shop fabricate elbows.]
 1. Fabricated Hanger Style: [Fig. 1-35A] [Fig. 1-35B] [Fig. 1-35C] [Fig. 1-35D] [Fig. 1-35E] [Fig. 1-35F] [Fig. 1-35G] [Fig. 1-35H] [Fig. 1-35I] [Fig. 1-35J] in accordance with SMACNA's "Architectural Sheet Metal Manual."
 2. Manufactured Hanger Style: [Fig. 1-34A] [Fig. 1-34B] [Fig. 1-34C] [Fig. 1-34D] [Fig. 1-34E] in accordance with SMACNA's "Architectural Sheet Metal Manual."
 3. Hanger Style: <Insert description>.
 4. Fabricate from the following materials:
 - a. Copper: [16 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.024 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 - g. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- D. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. [Fasten gravel guard angles to base of scupper.] Fabricate from the following materials:
 1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
- E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes[, exterior flange trim,] [and] [built-in overflows]. Fabricate from the following materials:
 1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.

5. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
6. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.

F. Splash Pans: Fabricate to dimensions and shape required and from the following materials:

1. Copper: [16 oz./sq. ft.] <Insert value>.
2. Aluminum: [0.040 inch] <Insert dimension> thick.
3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
5. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
6. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.

2.72.4 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum **96-inch** long, but not exceeding **12-foot** long sections. Furnish with **6-inch** wide, joint cover plates. [Shop fabricate interior and exterior corners.]

1. Joint Style: [Overlapped, **4 inches** wide] [Butted with expansion space and **6-inch** wide, concealed backup plate] [Butted with expansion space and **6-inch** wide, exposed cover plate] <Insert description>.
2. Fabricate with scuppers spaced [10 feet] <Insert dimension> apart, to dimensions required with **4-inch** wide flanges and base extending **4 inches** beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
3. Fabricate from the following materials:
 - a. Copper: [20 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.050 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [20 oz./sq. ft.] <Insert value>.
 - e. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 - g. Zinc: [0.048 inch] [0.059 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.

B. Copings: Fabricate in minimum **96-inch** long, but not exceeding **12-foot** long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and [drill elongated holes for fasteners on] interior leg. Miter corners, [fasten and seal] [solder or weld] watertight. [Shop fabricate interior and exterior corners.]

1. Coping Profile: [Fig. 3-4A] [Fig. 3-4B] [Fig. 3-4C] [Fig. 3-4D] [Fig. 3-4E] [Fig. 3-4F] [Fig. 3-4G] in accordance with SMACNA's "Architectural Sheet Metal Manual."
2. Joint Style: [Butted with expansion space and **6-inch** wide, concealed backup plate] [Butted with expansion space and **6-inch** wide, exposed cover plate] <Insert description>.
3. Fabricate from the following materials:
 - a. Copper: [24 oz./sq. ft.] <Insert value>.
 - b. Aluminum: [0.050 inch] <Insert dimension> thick.
 - c. Stainless Steel: [0.0250 inch] <Insert dimension> thick.
 - d. Zinc-Tin Alloy-Coated Copper: [24 oz./sq. ft.] <Insert value>.

- e. Galvanized Steel: [0.040 inch] <Insert dimension> thick.
 - f. Aluminum-Zinc Alloy-Coated Steel: [0.040 inch] <Insert dimension> thick.
 - g. Zinc: [0.048 inch] [0.059 inch] <Insert dimension> thick.
 - h. Copper-Clad Stainless Steel: [0.027 inch] <Insert dimension> thick.
- C. Expansion-Joint Cover: [Shop fabricate interior and exterior corners.]Fabricate [roof] [and] [roof-to-wall transition] [roof-to-roof edge-flashing (gravel-stop) transition] [roof-to-roof edge-flashing (gravel-stop) and fascia-cap transition] expansion-joint cover from the following materials:
- 1. Copper: [16 oz./sq. ft.] <Insert value>.
 - 2. Aluminum: [0.050 inch] <Insert dimension> thick.
 - 3. Stainless Steel: [0.0250 inch] <Insert dimension> thick.
 - 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - 5. Galvanized Steel: [0.034 inch] <Insert dimension> thick.
 - 6. Aluminum-Zinc Alloy-Coated Steel: [0.034 inch] <Insert dimension> thick.
 - 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - 8. Copper-Clad Stainless Steel: [0.027 inch] <Insert dimension> thick.
- D. Base Flashing: [Shop fabricate interior and exterior corners.]Fabricate from the following materials:
- 1. Copper: [20 oz./sq. ft.] <Insert value>.
 - 2. Aluminum: [0.040 inch] <Insert dimension> thick.
 - 3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 - 4. Zinc-Tin Alloy-Coated Copper: [20 oz./sq. ft.] <Insert value>.
 - 5. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 - 6. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 - 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - 8. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
- E. Counterflashing: [Shop fabricate interior and exterior corners.]Fabricate from the following materials:
- 1. Copper: [16 oz./sq. ft.] <Insert value>.
 - 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 - 3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 - 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 - 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 - 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 - 8. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
- F. Flashing Receivers: Fabricate from the following materials:
- 1. Copper: [16 oz./sq. ft.] <Insert value>.
 - 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 - 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 - 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 - 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 - 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 - 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.

8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 4. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 6. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
 8. Lead: [4 lb] <Insert weight>.
- H. Roof-Drain Flashing: Fabricate from the following materials:
1. Copper: [12 oz./sq. ft.] <Insert value>.
 2. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 3. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.

2.82.5 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- B. Valley Flashing: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 4. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 6. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
- C. Drip Edges: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.

5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- D. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- E. Counterflashing: [Shop fabricate interior and exterior corners.]Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
- F. Flashing Receivers: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Aluminum: [0.032 inch] <Insert dimension> thick.
 3. Stainless Steel: [0.0156 inch] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 5. Galvanized Steel: [0.022 inch] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [0.022 inch] <Insert dimension> thick.
 7. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [0.016 inch] <Insert dimension> thick.
- G. Roof-Penetration Flashing: Fabricate from the following materials:
1. Copper: [16 oz./sq. ft.] <Insert value>.
 2. Stainless Steel: [0.0188 inch] <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: [16 oz./sq. ft.] <Insert value>.
 4. Galvanized Steel: [0.028 inch] <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: [0.028 inch] <Insert dimension> thick.
 6. Zinc: [0.032 inch] [0.039 inch] <Insert dimension> thick.
 7. Copper-Clad Stainless Steel: [0.018 inch] <Insert dimension> thick.
 8. Lead: [4 lb] <Insert weight>.

2.92.6 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum **96-inch** long, but not exceeding **12-foot** long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend **6 inches** beyond each side of wall openings; and form with **2-inch** high, end dams. Fabricate from the following materials:
1. Copper: [**16 oz./sq. ft.**] <Insert value>.
 2. Stainless Steel: [**0.0156 inch**] <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft.**] <Insert value>.
 4. Zinc: [**0.032 inch**] [**0.039 inch**] <Insert dimension> thick.
 5. Copper-Clad Stainless Steel: [**0.016 inch**] <Insert dimension> thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, [jamb,] and similar flashings to extend [**4 inches**] <Insert dimension> beyond wall openings. Form head and sill flashing with **2-inch** high, end dams. Fabricate from the following materials:
1. Copper: [**16 oz./sq. ft.**] <Insert value>.
 2. Aluminum: [**0.032 inch**] <Insert dimension> thick.
 3. Stainless Steel: [**0.0156 inch**] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft.**] <Insert value>.
 5. Galvanized Steel: [**0.022 inch**] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [**0.022 inch**] <Insert dimension> thick.
 7. Zinc: [**0.032 inch**] [**0.039 inch**] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [**0.016 inch**] <Insert dimension> thick.
- C. Wall Expansion-Joint Cover: Fabricate from the following materials:
1. Copper: [**16 oz./sq. ft.**] <Insert value>.
 2. Aluminum: [**0.040 inch**] <Insert dimension> thick.
 3. Stainless Steel: [**0.0188 inch**] <Insert dimension> thick.
 4. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft.**] <Insert value>.
 5. Galvanized Steel: [**0.028 inch**] <Insert dimension> thick.
 6. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch**] <Insert dimension> thick.
 7. Zinc: [**0.032 inch**] [**0.039 inch**] <Insert dimension> thick.
 8. Copper-Clad Stainless Steel: [**0.018 inch**] <Insert dimension> thick.

2.102.7 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
1. Copper: [**16 oz./sq. ft.**] <Insert value>.
 2. Stainless Steel: [**0.0188 inch**] <Insert dimension> thick.
 3. Zinc-Tin Alloy-Coated Copper: [**16 oz./sq. ft.**] <Insert value>.
 4. Galvanized Steel: [**0.028 inch**] <Insert dimension> thick.
 5. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch**] <Insert dimension> thick.
 6. Copper-Clad Stainless Steel: [**0.018 inch**] <Insert dimension> thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Copper: [24 oz./sq. ft.] <Insert value>.
2. Stainless Steel: [0.0250 inch] <Insert dimension> thick.
3. Zinc-Tin Alloy-Coated Copper: [24 oz./sq. ft.] <Insert value>.
4. Galvanized Steel: [0.040 inch] <Insert dimension> thick.
5. Aluminum-Zinc Alloy-Coated Steel: [0.040 inch] <Insert dimension> thick.
6. Copper-Clad Stainless Steel: [0.027 inch] <Insert dimension> thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 1. Verify compliance with requirements for installation tolerances of substrates.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
 1. Install in shingle fashion to shed water.
 2. Lap joints not less than 2 inches.
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
 1. Lap horizontal joints not less than 4 inches.
 2. Lap end joints not less than 12 inches.
- C. Self-Adhering, High-Temperature Sheet Underlayment:
 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 2. Prime substrate if recommended by underlayment manufacturer.
 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
 6. Roll laps and edges with roller.
 7. Cover underlayment within 14 days.
- D. Install slip sheet, wrinkle free, [over underlayment] [directly on substrate] <Insert requirement> before installing sheet metal flashing

and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than **4 inches**.

3.3 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners[, **solder**], protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of [**solder**] [**welds**] [**sealant**].
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than **12 inches** o.c.
 6. Space individual cleats not more than **12 inches** apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of [**uncoated-aluminum**] [**and**] [**stainless steel**] sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of [**10 feet**] <Insert dimension> with no joints within **24 inches** of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate [**wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws**] [**substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance**] <Insert size requirement>.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than **1 inch** into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between **40 and 70 deg F**, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below **40 deg F**.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pretin edges of sheets with solder to width of **1-1/2 inches**; however, reduce pretinning where pretinned surface would show in completed Work.
 2. Do not solder **[metallic-coated steel]** **[and]** **[aluminum]** sheet.
 3. Do not pretin zinc-tin alloy-coated copper.
 4. Do not use torches for soldering.
 5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
 6. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
 8. Copper-Clad Stainless Steel Soldering: Tin edges of uncoated sheets, using solder for copper-clad stainless steel.
- H. Rivets: Rivet joints in **[uncoated aluminum]** **[zinc]** where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
1. Join sections with **[riveted and soldered joints]** **[or]** **[joints sealed with sealant]**.
 2. Provide for thermal expansion.
 3. Attach gutters at eave or fascia to firmly anchor them in position.
 4. Provide end closures and seal watertight with sealant.
 5. Slope to downspouts.
 6. Fasten gutter spacers to front and back of gutter.
 7. Anchor and loosely lock back edge of gutter to continuous **[cleat]** **[eave or apron flashing]**.

8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [24 inches] <Insert dimension> apart.
9. Anchor gutter with [gutter brackets] [straps] [twisted straps] spaced not more than [24 inches] [30 inches] [36 inches] <Insert dimension> apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
10. Anchor gutter with spikes and ferrules spaced not more than [24 inches] [30 inches] <Insert dimension> apart.
11. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [50 feet] <Insert dimension> apart. Install expansion-joint caps.
12. Install continuous gutter screens on gutters with noncorrosive fasteners, [removable] [hinged to swing open] for cleaning gutters.

C. Built-in Gutters:

1. Join sections with [riveted and soldered joints] [or] [joints sealed with sealant].
2. Provide for thermal expansion.
3. Slope to downspouts.
4. Provide end closures and seal watertight with sealant.
5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.
 - a. Lap sides minimum of 2 inches over underlying course.
 - b. Lap ends minimum of 4 inches.
 - c. Stagger end laps between succeeding courses at least 72 inches.
 - d. Fasten with roofing nails.
 - e. Install slip sheet over underlayment.
6. Anchor and loosely lock back edge of gutter to continuous [cleat] [eave or apron flashing].
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than [18 inches] <Insert dimension> apart.
8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, [50 feet] <Insert dimension> apart. Install expansion-joint caps.

D. Downspouts:

1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

E. Splash Pans:

1. Install where downspouts discharge on [low-slope roofs] <Insert surface>.
2. Set in [asphalt roofing cement] [or] [elastomeric sealant] compatible with the substrate.

F. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and [solder] [or] [seal with elastomeric sealant] to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. [Solder] [or] [seal with elastomeric sealant] exterior wall scupper flanges into back of conductor head.

- G. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of **1 inch** below [scupper] [or] [gutter] discharge.
- H. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of **4 inches** in direction of water flow.

3.5 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements[, **sheet metal manufacturer's written installation instructions,**] and cited sheet metal standard.
 - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
 - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at [staggered **3-inch**] <Insert spacing> centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- C. Copings:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at [**24-inch**] [**16-inch**] <Insert dimension> centers.
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at [**24-inch**] <Insert dimension> centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches** over base flashing. Install stainless steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
 - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 - 2. Extend counterflashing **4 inches** over base flashing.
 - 3. Lap counterflashing joints minimum of **4 inches**.
 - 4. Secure in waterproof manner by means of [snap-in installation and sealant or lead wedges and sealant] [interlocking folded seam or blind rivets and sealant] [anchor and washer spaced at **12 inches** o.c. along perimeter and **6 inches** o.c. at corners areas] <Insert requirement> unless otherwise indicated.

- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with [elastomeric] [butyl] sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, [jamb,] and similar flashings to extend [4 inches] <Insert dimension> beyond wall openings.
- C. Reglets: Installation of reglets is specified in [Section 033000 "Cast-in-Place Concrete."] [Section 042000 "Unit Masonry."] Section <Insert Section number> "<Insert Section title>."

3.7 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
 - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
 - 2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
 - 1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
 - 2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.10 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077100 - 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. ~~Related Requirements:~~

1. ~~Section 055000 "Metal Fabrications" for downspout guards and downspout boots.~~
2. ~~Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.~~
3. ~~Section 074113.13 "Formed Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.~~
4. ~~Section 074113.16 "Standing-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.~~
5. ~~Section 074113.19 "Batten-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.~~
6. ~~Section 074116 "Insulated Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.~~
7. ~~Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.~~
8. ~~Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint cover assemblies.~~
9. ~~Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof-accessory units.~~
10. ~~Section 077253 "Snow Guards" for manufactured snow guard devices.~~
11. ~~Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.~~

C.B. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copings.
2. Roof-edge specialties.

3. Roof-edge drainage systems.
 4. Reglets and counterflashings.
 - B. Product Data Submittals: For each product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - C. Sustainable Design Submittals:
 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - D. 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.
 2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 4. Detail termination points and assemblies, including fixed points.
 5. Include details of special conditions.
 - E. Samples: For each type of roof specialty and for each color and texture specified.
 - F. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
 - G. Samples for Verification:
 1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
 2. Include [copings] [roof-edge specialties] [roof-edge drainage systems] [reglets and counterflashings] made from 12-inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.
- 1.3 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For manufacturer.
 - B. Product Certificates: For each type of roof specialty.
 - C. Product Test Reports: For [copings] [and] [roof-edge flashings], for tests performed by a qualified testing agency.
 - D. Sample Warranty: For manufacturer's special 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 [FM Approvals listed for

specified class] [and] [SPRI ES-1 tested to specified design pressure].

1.6 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof edge as indicated on Drawings.
 - 2. Build mockup of typical roof edge as part of Integrated Exterior Mockup specified in Section 014000 "Quality Requirements"
 - 3. Build mockup of typical roof edge, including [fascia] [gutter] [and] [downspout] <Insert item>, approximately [10 feet] <Insert dimension> long, including supporting construction, seams, attachments, [underlayment,] and accessories.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section <Insert Section number> "<Insert roof Section title>."
- 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 in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: [20] [10] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section <Insert Section number and title>.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.
- C. FM Approvals' Listing: Manufacture and install [copings] [roof-edge specialties] that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, [Class 1-60] [Class 1-75] [Class 1-90] [Class 1-105] [Class 1-120] <Insert class>. Identify materials with FM Approvals' markings.
- D. SPRI Wind Design Standard: Manufacture and install [copings] [roof-edge specialties] tested in accordance with SPRI ES-1 and capable of resisting the following design pressures:
1. Design Pressure: [As indicated on Drawings] <Insert design pressure>.
- E. 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, ambient; 180 deg F] <Insert temperature range>, material surfaces.

2.3 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, **G90** coating designation.
- B. Aluminum Sheet: **ASTM B209**, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Aluminum Extrusions: **ASTM B221**, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- E. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.4 ~~UNDERLAYMENT MATERIALS~~

- A. ~~Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.~~
- B. ~~Slip Sheet: Resin-sized building paper, 3-lb./100-sq. ft. minimum.~~

2.52.4 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 in accordance with ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric ~~[polyurethane]~~ **[silicone]** 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.
- F. Solder for Copper: ASTM B32, ~~[lead-free solder]~~ **[Grade Sn50, 50 percent tin and 50 percent lead]** <Insert solder grade>.

2.62.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. 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. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with

- coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
- b. 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. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - c. Two-Coat Mica Fluoropolymer: AAMA 621. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - d. Three-Coat Metallic Fluoropolymer: AAMA 621. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil**.

E. Coil-Coated Aluminum Sheet Finishes:

- 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - b. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - c. Two-Coat Mica Fluoropolymer: AAMA 2605. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - d. Three-Coat Metallic Fluoropolymer: AAMA 2605. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions[**for seacoast and severe environments**].
 - e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil**.
- 2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- 3. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.

F. Aluminum Extrusion Finishes:

- 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish containing not less than 70 percent

- polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- b. Three-Coat Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Two-Coat Mica Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - d. Three-Coat Metallic Fluoropolymer: AAMA [2604] [2605]. Fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - e. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of **0.5 mil**.
2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
 3. Color Anodic Finish: AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
- G. Copper Sheet Finishes:
1. Non-Patinated Finish: Mill finish.
 2. Pre-Patinated Finish: Chemically treated in accordance with ASTM B882.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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 wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches** staggered **24 inches** between courses. Overlap side edges not less than **3-1/2 inches**. Roll laps with roller. Cover underlayment within 14 days.
 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. Felt Underlayment: Install with 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**.
- C. 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**.

3.3 INSTALLATION, GENERAL

- A. Install roof specialties in accordance with 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]** **[and]** **[stainless steel]** 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]** **<Insert dimension>** with no joints within **[18 inches]** **<Insert dimension>** of corners or intersections unless otherwise indicated on Drawings.
 - 2. When ambient temperature at time of installation is between **40 and 70 deg F**, 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 for nails and not less than 3/4 inch for wood screws]** **[substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance]** **<Insert size requirement>**.
- 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**.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of **1-1/2 inches**; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 — INSTALLATION OF COPINGS

- 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 ~~[30-inch centers]~~ **[40-inch centers]** ~~[manufacturer's required spacing that meets performance requirements]~~ **<Insert spacing>**.
 - 2. — Interlock face-leg drip edge into continuous cleat anchored to substrate at ~~[24-inch centers]~~ **[16-inch centers]** ~~[manufacturer's required spacing that meets performance requirements]~~ **<Insert spacing>**. Anchor back leg of coping with screw fasteners and elastomeric washers at ~~[24-inch centers]~~ **[16-inch centers]** ~~[manufacturer's required spacing that meets performance requirements]~~ **<Insert spacing>**.

3.53.4 — 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.

3.6 — INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

- A. — Install components to produce a complete roof-edge drainage system in accordance with 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 ~~[12 inches]~~ **[24 inches]** ~~[30 inches]~~ **<Insert dimension>** apart. Attach ends with rivets and ~~[seal with sealant]~~ **[solder]** to make watertight. Slope to downspouts.
 - 1. — Install gutter with expansion joints at locations indicated but not exceeding ~~[50 feet]~~ **<Insert dimension>** apart. Install expansion-joint caps.
 - 2. — Install continuous leaf guards on gutters with noncorrosive fasteners, ~~[removable]~~ **[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** away from walls; locate fasteners at top and bottom and at approximately ~~[60 inches]~~ **<Insert dimension>** 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.
- D. — Splash Pans: Install where downspouts discharge on ~~[low-slope roofs]~~ **<Insert surface>**. Set in ~~[asphalt roofing cement]~~ **[elastomeric sealant]**.
- E. — Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. — Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
 - 2. — Loosely lock front edge of scupper with conductor head.

3. ~~Seal or solder exterior wall scupper flanges into back of conductor head.~~

F. ~~Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below [scupper] [gutter] discharge.~~

3.7 ~~INSTALLATION OF REGLETS AND COUNTERFLASHINGS~~

A. ~~Coordinate installation of reglets and counterflashings with installation of base flashings.~~

B. ~~Embedded Reglets: See [Section 033000 "Cast-in-Place Concrete"] [and] [Section 042000 "Unit Masonry"] for installation of reglets.~~

C. ~~Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.~~

D. ~~Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.~~

3.83.5 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. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. — Roof curbs.
2. — Equipment supports.
3. — Roof hatches.
4. — Heat and smoke vents.
5. — Gravity ventilators.
6. — Pipe and duct supports.
7. — Pipe portals.
8. — Preformed flashing sleeves.
9. — Roof walkways.

B. — Related Requirements:

1. — Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. — Section 055213 "Pipe and Tube Railings" for safety railing systems not attached to roof-hatch curbs.
3. — Section 076100 "Sheet Metal Roofing" for shop- and field-formed roof curbs and snow guards for sheet metal roofing.
4. — Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
5. — Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.
6. — Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.
7. — Section 077253 "Snow Guards" for snow guards.
8. — Section 086200 "Unit Skylights" for single- and double-glazed domed plastic skylights with curb frame.
9. — Section 230548 "Vibration and Seismic Controls for HVAC" for special curbs designed to accommodate seismic and vibration controls.
10. — Section 233423 "HVAC Power Ventilators" for power roof-mounted ventilators.
11. — Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units" for standard curbs specified with rooftop units.
12. — [Section 284621.11 "Addressable Fire Alarm Systems"] [Section 28462.13 "Conventional Fire Alarm Systems"] for interconnects to automatically operated heat and smoke vents.

1.2 COORDINATION

- A. Coordinate layout and installation of roof accessories with [roofing membrane and base flashing and] interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.
- D. Delegated Design Submittals: For **[roof curbs]** **[equipment supports]** **[and]** **[walkways]** indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
 - 2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.6 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 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] [10] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [roof curbs] [and] [equipment supports] to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: [As indicated on Drawings] <Insert requirements>.

2.2 ~~ROOF CURBS~~

- A. ~~Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.~~
- B. ~~Supported Load Capacity: [Coordinate load capacity with information on Shop Drawings of equipment to be supported] <Insert load requirements>.~~
- C. ~~Steel: [Zinc-coated (galvanized)] [Aluminum-zinc alloy-coated] steel sheet, [0.052 inch] [0.064 inch] [0.079 inch] <Insert dimension> thick.~~
 - 1. ~~Finish: [Mill-phosphatized] [Factory prime coating] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
 - 2. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~
- D. ~~Aluminum: [0.090 inch] [0.125 inch] <Insert dimension> thick sheet.~~
 - 1. ~~Finish: [Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
 - 2. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>.~~
- E. ~~Stainless Steel: [0.0781 inch] <Insert dimension> thick sheet.~~
 - 1. ~~Finish: [Manufacturer's standard] [ASTM A480/A480M, No. 2D, directional polish finish] <Insert finish>.~~
- F. ~~Construction:~~
 - 1. ~~Curb Profile: [Manufacturer's standard] [Profile as indicated on Drawings] compatible with roofing system.~~
 - 2. ~~On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.~~
 - 3. ~~Fabricate curbs to minimum height of [12 inches] <Insert dimension> above roofing surface unless otherwise indicated.~~
 - 4. ~~Top Surface: Level top of curb, with roof slope accommodated [by sloping deck-mounting flange] [or] [by use of leveler~~

~~frame~~].

5. ~~Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.~~
6. ~~Insulation: Factory insulated with [1-1/2-inch] <Insert dimension> thick glass-fiber board insulation.~~
7. ~~Liner: Same material as curb, of manufacturer's standard thickness and finish.~~
8. ~~Nailer: Factory-installed wood nailer [along top flange of curb] [under top flange on side of curb], continuous around curb perimeter.~~
9. ~~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.~~
10. ~~Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.~~
11. ~~Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.~~
12. ~~Security Grille: [Provide for all units] [Provide where indicated].~~
13. ~~Damper Tray: Provide damper tray or shelf with opening [3 inches] <Insert dimension> [less than interior curb dimensions indicated] [of size indicated].~~

2.3 EQUIPMENT SUPPORTS

- A. ~~Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.~~
- B. ~~Supported Load Capacity: [Coordinate load capacity with information on Shop Drawings of equipment to be supported] <Insert load requirements>.~~
- C. ~~Steel: [Zinc-coated (galvanized)] [Aluminum-zinc alloy-coated] steel sheet, [0.052 inch] [0.064 inch] [0.079 inch] <Insert dimension> thick.~~
 1. ~~Finish: [Mill phosphatized] [Factory prime coating] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
 2. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~
- D. ~~Aluminum: [0.090 inch] [0.125 inch] <Insert dimension> thick sheet.~~
 1. ~~Finish: [Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
 2. ~~Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>.~~
- E. ~~Stainless Steel: [0.0781 inch] <Insert dimension> thick sheet.~~
 1. ~~Finish: [Manufacturer's standard] [ASTM A480/A480M, No. 2D, directional polish finish] <Insert finish>.~~
- F. ~~Construction:~~
 1. ~~Curb Profile: [Manufacturer's standard] [Profile as indicated on Drawings] compatible with roofing system.~~
 2. ~~Insulation: Factory insulated with [1-1/2-inch] <Insert dimension> 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] [5-1/2 inches] <Insert dimension> wide [on top flange of~~

- ~~equipment supports~~] ~~[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~~ 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. ~~On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.~~
 9. ~~Fabricate equipment supports to minimum height of [12 inches] <Insert dimension> above roofing surface unless otherwise indicated.~~
 10. ~~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.
 11. ~~Security Grille:~~ ~~[Provide for all units]~~ ~~[Provide where indicated on Drawings]~~.

2.4 ROOF HATCHES

A. Type and Size:

1. ~~Single-leaf lid, [30 by 36 inches] [36 by 36 inches] [30 by 54 inches] [30 by 96 inches] <Insert dimensions>.~~
2. ~~Double-leaf lid, [72 by 96 inches] <Insert dimensions>.~~

B. Loads: Minimum [40-lbf/sq. ft.] <Insert value> external live load and [20-lbf/sq. ft.] <Insert value> internal uplift load.

1. ~~Dome Glazing:~~ Minimum [40-lbf/sq. ft.] <Insert value> external live load and [20-lbf/sq. ft.] <Insert value> internal uplift load.

C. Hatch Material, Steel: ~~[Zinc-coated (galvanized)] [Aluminum-zinc alloy-coated]~~ steel sheet.

1. ~~Thickness:~~ ~~[Manufacturer's standard thickness for hatch size indicated] [0.079 inch] <Insert dimension>.~~
2. ~~Finish:~~ ~~[Mill phosphatized] [Factory prime coating] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
3. ~~Color:~~ ~~[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.~~

D. Hatch Material, Aluminum:

1. ~~Thickness:~~ ~~[Manufacturer's standard thickness for hatch size indicated] [0.079 inch] <Insert dimension>.~~
2. ~~Finish:~~ ~~[Mill] [Factory prime coating] [Clear anodic] [Color anodic] [Two-coat fluoropolymer] [Baked enamel or powder coat] <Insert finish>.~~
3. ~~Color:~~ ~~[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] [Light bronze] [Medium bronze] [Dark bronze] <Insert color>.~~

E. Hatch Material, Stainless Steel:

1. ~~Thickness:~~ ~~[Manufacturer's standard thickness for hatch size indicated] [0.0781 inch] <Insert dimension>.~~
2. ~~Finish:~~ ~~[Manufacturer's standard] [ASTM A480/A480M, No. 2D, directional polish finish] <Insert finish>.~~

F. Construction:

1. ~~Insulation:~~ ~~[1-inch thick, cellulose-fiber board] [1-inch thick, glass-fiber board] [2-inch thick, polyisocyanurate board].~~

- a. — R-Value: ~~[2.78]~~ ~~[4.3]~~ ~~[12.0]~~ ~~<Insert R-value>~~ according to ASTM C1363.
2. — Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. — Hatch Lid: ~~[Opaque]~~ ~~[Glazed]~~, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. — Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. — On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. — Fabricate curbs to minimum height of ~~[12 inches]~~ ~~<Insert dimension>~~ above roofing surface unless otherwise indicated.
7. — Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is ~~[constant]~~ ~~[tapered to accommodate roof slope so that top surfaces of perimeter curb are level]~~. Equip hatch with water diverter or cricket on side that obstructs water flow.
- G. — Hatch Lid Glazing: ~~[Single]~~ ~~[Double]~~ ~~[acrylic]~~ ~~[polycarbonate]~~ glazing of thickness capable of resisting indicated loads.
1. — Single-Dome Color: ~~[Colorless, transparent]~~ ~~[White, translucent]~~ ~~[Gray tinted, transparent]~~ ~~[Bronze tinted, transparent]~~ ~~<Insert requirement>~~.
2. — Outer Double-Dome Color: ~~[Colorless, transparent]~~ ~~[White, translucent]~~ ~~[Gray tinted, transparent]~~ ~~[Bronze tinted, transparent]~~ ~~<Insert requirement>~~.
3. — Inner Double-Dome Color: ~~[Colorless, transparent]~~ ~~[White, translucent]~~ ~~[Gray tinted, transparent]~~ ~~[Bronze tinted, transparent]~~ ~~<Insert requirement>~~.
- H. — Hardware: Spring operators, hold-open arm, ~~[galvanized]~~ ~~[stainless]~~ steel spring latch with turn handles, ~~[galvanized]~~ ~~[stainless]~~ steel butt or pintle-type hinge system, and padlock hasps inside and outside.
1. — Provide two-point latch on lids larger than **84 inches**.
2. — Provide remote-control operation.
- I. — Safety Railing System: Roof hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
1. — Height: ~~[42 inches]~~ ~~<Insert dimension>~~ above finished roof deck.
2. — Posts and Rails: Galvanized steel pipe, **1-1/4 inches** in diameter or galvanized steel tube, **1-5/8 inches** in diameter.
3. — Flat Bar: Galvanized steel, **2 inches** high by **3/8 inch** thick.
4. — Maximum Opening Size: System constructed to prevent passage of a sphere **21 inches** in diameter.
5. — Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
6. — Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
7. — Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
8. — Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
9. — Fabricate joints exposed to weather to be watertight.
10. — Fasteners: Manufacturer's standard, finished to match railing system.
11. — Finish: ~~[Manufacturer's standard]~~ ~~<Insert finish>~~.
- a. — Color: ~~[As indicated by manufacturer's designations]~~ ~~[Match Architect's sample]~~ ~~[As selected by Architect from manufacturer's full range]~~ ~~<Insert color>~~.
- J. — Ladder-Assist Post: Roof hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: [42 inches] <Insert dimension> above finished roof deck.
3. Material: [Steel tube] [Stainless steel] [Aluminum].
4. Post: [1-5/8-inch] <Insert dimension> diameter pipe.
5. Finish: [Manufacturer's standard baked enamel or powder coat] <Insert finish>.

- a. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

2.5 PIPE AND DUCT SUPPORTS

- A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to [1-1/2-inch] <Insert dimension> diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with [polycarbonate] [stainless steel] roller-carrying assembly accommodating up to [7-inch] <Insert dimension> diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to [18-inch] <Insert dimension> diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
- D. Adjustable-Height Structure-Mounted Pipe Supports: Extruded-aluminum tube, filled with urethane insulation; [2 inches] <Insert dimension> in diameter; accommodating up to [7-inch] <Insert dimension> diameter pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded-aluminum carrier assemblies; as required for quantity of pipe runs and sizes.

2.62.2 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, **G90** coating designation [and mill phosphatized for field painting where indicated].
 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil**.
 3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 4. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils**.
 5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of

prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil**.

- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, **AZ50** coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil**.
 2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils**.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil**.
- C. Aluminum Sheet: **ASTM B209**, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Mill Finish: As manufactured.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of **0.2 mil**.
 3. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**] [**AA-M12C22A31, Class II, 0.010 mm**] or thicker.
 4. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**] [**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.
 5. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
 6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 7. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of **0.5 mil**.
- D. Aluminum Extrusions and Tubes: **ASTM B221**, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.
- F. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- G. Steel Tube: ASTM A500/A500M, round tube.
- H. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- I. Steel Pipe: ASTM A53/A53M, galvanized.

2.72.3 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).
- C. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated according to UL 972 with an average impact strength of [12 to 16 ft-lbf/in.] <Insert value> of width when tested according to ASTM D256, Method A (Izod).
- D. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.
- E. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- F. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- G. 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 thick.
- H. Security Grilles: [3/4-inch] <Insert dimension> diameter, ASTM A1011/A1011M steel bars spaced [6 inches] <Insert dimension> o.c. in one direction and [12 inches] <Insert dimension> o.c. in the other; factory finished as follows:
 - 1. Surface Preparation: Remove mill scale and rust, if any, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
 - 3. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats under prolonged exposure.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Underlayment:
 - 1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 - 2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D4397.
 - 3. Slip Sheet: Building paper, 3 lb/100 sq. ft. minimum, rosin sized.
 - 4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils 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.
- K. 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:
 - 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- L. 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.
- M. Elastomeric Sealant: ASTM C920, elastomeric **[polyurethane]** **[silicone]** 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.
- N. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- O. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.82.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. 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. Coat concealed side of [uncoated aluminum] [stainless steel] roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Attach ladder-assist post according to manufacturer's written instructions.
- F. Heat and Smoke Vent Installation:
1. Install heat and smoke vent so top perimeter surfaces are level.
 2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.
- G. Gravity Ventilator Installation: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.
- H. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- I. Preformed Flashing-Sleeve and Flashing-Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.
- J. Security Grilles: Weld bar intersections and[, using tamper-resistant bolts, attach the] ends of bars to structural frame or primary curb walls.
- K. Roof Walkway Installation:
1. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.
 2. Remove ballast from top surface of low-slope roofing at locations of contact with roof-walkway supports.
 3. Install roof walkway support pads prior to placement of roof walkway support stands onto low-slope roofing.
 4. Redistribute removed ballast after installation of support pads.
- L. Seal joints with [elastomeric] [or] [butyl] sealant as required by roof accessory manufacturer.

3.3 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 099113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Silicone joint sealants.~~
- ~~2. Nonstaining silicone joint sealants.~~
- ~~3. Urethane joint sealants.~~
- ~~4. Immersible joint sealants.~~
- ~~5. Silane-modified polymer joint sealants.~~
- ~~6. Mildew-resistant joint sealants.~~
- ~~7. Polysulfide joint sealants.~~
- ~~8. Butyl joint sealants.~~
- ~~9. Latex joint sealants.~~

B. ~~Related Requirements:~~

- ~~1. Section 079100 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.~~
- ~~2. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.~~
- ~~3. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.~~

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silane-modified polymer joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in ~~1/2-inch~~ wide joints formed between two ~~6-inch~~ long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. 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. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- B. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material to be tested from sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- D. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.
- E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Manufacturers' special warranties.
- B. Installer's special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 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 [stone] [masonry] <Insert substrate> substrates.
 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
 2. Conduct field tests for each kind of sealant and joint substrate.
 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 5. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[or are below 40 deg F].

2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 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]** <Insert number> 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]** <Insert number> years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer[**for each sealant type**].

2.2 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: **[As indicated by manufacturer's designations]** **[Match Architect's samples]** **[As selected by Architect from manufacturer's full range]**.

~~2.3 NONSTAINING SILICONE JOINT SEALANTS~~

- ~~A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.~~

2.4 IMMERSIBLE JOINT SEALANTS

- A. Immersible Joint Sealants: Suitable for immersion in liquids; ASTM C1247, ~~[Class 1]~~ **[Class 2]**; tested in deionized water unless otherwise indicated.

2.5 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

2.6 JOINT-SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C1330, ~~[Type C (closed-cell material with a surface skin)] [Type O (open-cell material)] [Type B (bicellular material with a surface skin)] [or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated]~~, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7.2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - e. <Insert other porous joint substrate>.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
 - e. <Insert other nonporous joint substrate>.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide flush joint profile at [locations indicated on Drawings] <Insert locations> in accordance with Figure 8B in ASTM C1193.
 - 5. Provide recessed joint configuration of recess depth and at [locations indicated on Drawings] <Insert locations> in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - a. Extent of Testing: Test completed and cured sealant joints as follows:
 - 1) Perform [10] <Insert number> tests for the first [1000 ft.] <Insert dimension> of joint length for each kind of sealant and joint substrate.
 - 2) Perform one test for each [1000 ft.] <Insert dimension> of joint length thereafter or one test per each floor per elevation.
 - b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - c. Inspect tested joints and report on the following:
 - 1) Whether sealants filled joint cavities and are free of voids.
 - 2) Whether sealant dimensions and configurations comply with specified requirements.
 - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

- d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 - e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - 2. 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.
- C. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standard steel frames.
2. Exterior standard steel frames.
3. Interior custom hollow-metal frames.
4. Exterior custom hollow-metal frames.
5. Borrowed lites.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for hollow-metal doors and frames.
2. Section 081119 "Stainless Steel Doors and Frames" for hollow-metal doors and frames manufactured from stainless steel.
3. [Section 087100 "Door Hardware"] [Section 087111 "Door Hardware (Descriptive Specification)"] for door hardware for hollow-metal doors.

1.2 DEFINITIONS

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

1.3 COORDINATION

- A.** Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B.** Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:** Conduct conference at [Project site] <Insert location>.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Interior standard steel frames.
2. Exterior standard steel frames.

3. Interior custom hollow-metal frames.
 4. Exterior custom hollow-metal frames.
 5. Borrowed lites.
- B. Product Data Submittals: For each product.
1. Include construction details, material descriptions, **[fire-resistance ratings,]** and finishes.
- C. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. Environmental Product Declaration: For each product.
 3. Health Product Declaration: For each product.
 4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 5. Environmental Product Declaration: For each product.
 6. Environmental Product Declaration: For each product.
 7. Environmental Product Declaration: For each product.
 8. Third-Party Certifications: For each product.
 9. Third-Party Certified Life Cycle Assessment: For each product.
- D. Shop Drawings: Include the following:
1. Elevations of each frame type.
 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 3. Locations of reinforcement and preparations for hardware.
 4. Details of each different wall opening condition.
 5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of moldings, removable stops, and glazing.
- E. Samples for Initial Selection: For hollow-metal frames with factory-applied color finishes.
- F. Samples for Verification:
1. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches**.
 2. Fabrication: Prepare Samples approximately **[12 by 12 inches] [8 by 10 inches]** **<Insert dimension>** to demonstrate compliance with requirements for quality of materials and construction. Show profile, corner joint, floor and wall anchors, and silencers.
- G. Product Schedule: For hollow-metal 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of **[fire-rated hollow-metal frame assembly]** **[and]** **[fire-rated borrowed-lite assembly]** for tests performed by a qualified testing agency indicating compliance with performance requirements.
- B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum **4-inch** high wood blocking. Provide minimum **1/4-inch** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated 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 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.
 - 2. Oversize Fire-Rated Frames: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that frames comply with standard construction requirements for tested and labeled fire-rated assemblies except for size.
- B. Fire-Rated, Borrowed-Life Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.2 STANDARD STEEL FRAMES

- A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Standard Steel Frames: SDI A250.8. **[At locations indicated in the Door and Frame Schedule on Drawings]** **<Insert locations>**.
 - 1. Materials: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of **[0.042 inch]** **[0.053 inch]** **[0.067 inch]**.
 - 2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - 3. Construction: **[Knocked down]** **[Slip-on drywall]** **[Face welded]** **[Full profile welded]**.
 - 4. Exposed Finish: **[Prime]** **[Factory]**.
- C. Exterior Standard Steel Frames: SDI A250.8. **[At locations indicated in the Door and Frame Schedule on Drawings]** **<Insert locations>**.
 - 1. Materials: Metallic-coated steel sheet, minimum thickness of **[0.053 inch]** **[0.067 inch]**, with minimum **[A40]** **[A60]** coating.
 - 2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - 3. Construction: **[Knocked down]** **[Face welded]** **[Full profile welded]**.

4. Exposed Finish: **[Prime]** **[Factory]**.

2.3 CUSTOM HOLLOW-METAL FRAMES

- A. Interior Custom Hollow-Metal Frames: NAAMM-HMMA 861. **[At locations indicated in the Door and Frame Schedule on Drawings]**
<Insert locations>.
 1. Materials: **[Uncoated]** **[Metallic-coated]** steel sheet, minimum thickness of **0.053 inch**.
 2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 3. Construction: **[Knocked down]** **[Slip-on drywall]** **[Face welded]** **[Full profile welded]**.
 4. Exposed Finish: Prime.
- B. Exterior Custom Hollow-Metal Frames: NAAMM-HMMA 861. **[At locations indicated in the Door and Frame Schedule on Drawings]**
<Insert locations>.
 1. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch**.
 2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 3. Construction: **[Knocked down]** **[Face welded]** **[Full profile welded]**.
 4. Exposed Finish: Prime.

2.4 BORROWED LITES

- A. Fabricate of **[uncoated]** **[metallic-coated]** steel sheet, minimum thickness of **[0.053 inch]** **[0.042 inch]**.
- B. Construction: **[Knocked down]** **[Face welded]** **[Full profile welded]**.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

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** of frame height above **7 feet**.
 3. Postinstalled Expansion Anchor: Minimum **3/8-inch** 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** height adjustment. Terminate bottom of frames at top of underlayment.

- D. Material: ASTM A879/A879M, Commercial Steel (CS), **04Z** 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] <Insert value> 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. Glazing: Comply with requirements in Section 088000 "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. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding[, or by rigid mechanical anchors].
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. 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.
 - 4. Terminated Stops: Terminate stops [6 inches] <Insert dimension> above finish floor with a [45] [90]-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with **[butted]** **[or]** **[mitered]** hairline joints.
 - 1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 2. Provide fixed frame moldings on outside of exterior and on secure side of interior frames. Provide loose stops and moldings on inside of hollow-metal frames.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than **9 inches** o.c. and not more than **2 inches** o.c. from each corner.

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 SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
- B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.
 - 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** <Insert color and gloss>.

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 frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with **[SDI A250.11]** **[NAAMM-HMMA 840]**.
- B. 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.
 - 1. 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.
 - 2. Install frames with removable stops located on secure side of opening.

- C. Fire-Rated Openings: Install frames according to NFPA 80.
- D. Floor Anchors: Secure with postinstalled expansion anchors.
 - 1. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- E. Solidly pack mineral-fiber insulation inside frames.
- F. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
- G. 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.**]
- H. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - 1. Squareness: Plus or minus **1/16 inch**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus **1/16 inch**, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus **1/16 inch**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus **1/16 inch**, measured at jambs at floor.
- I. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

- 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. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081216 - ALUMINUM FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Interior aluminum doors, door frames, and glazing frames.~~

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Interior aluminum doors, door frames, and glazing frames.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, [fire-resistance rating,]and finishes.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Shop Drawings: For aluminum frames:

1. Include elevations, sections, and installation details for each wall-opening condition.
2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
3. Include locations of reinforcements and preparations for hardware.
4. Include details of anchorages, joints, field splices, connections, and accessories.
5. Include details of moldings, removable stops, and glazing.

E. Samples: For each exposed product and for each color and texture specified, [in manufacturer's standard sizes] [6 inches square in size] <Insert dimensions>.

F. Samples for Initial Selection: For each type of exposed finish.

1. Include Samples of seals, gaskets, and accessories involving color selection.

G. Samples for Verification: For each type of the following products:

1. Framing Member and Finish: **12 inches** long. Include trim.
 2. Corner Fabrication and Finish: **12-by-12-inch** long, full-size window corner, including full-size sections of extrusions with factory-applied color finish.
 3. Door Finish: Manufacturer's standard-size unit, but not less than **[3 inches square]** <Insert dimensions>.
- H. Product Schedule: For aluminum frames. [**Use same designations indicated on Drawings.**] Coordinate with door hardware schedule and glazing.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum frames to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
1. Build mockup of each type of aluminum frame [**and door**] in typical wall area as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. 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 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Frames: Frames for fire-rated door assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to **[NFPA 252]** [or] **[UL 10C]**.
1. Oversize Fire-Rated Frames: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that frames comply with standard construction requirements for tested and labeled fire-rated frames except for size.
 2. Frames for Smoke- and Draft-Control Assemblies: Tested according to UL 1784 and installed in compliance with NFPA 105.
 - a. Air Leakage Rate: Maximum air leakage of **0.3 cfm/sq. ft.** at the tested pressure differential of **0.3-inch wg.**

2.2 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic, stainless steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals in **[black]** <Insert color> color.
- C. Smoke Seals: Intumescent strip or fire-rated gaskets in **[black]** <Insert color>.

- D. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in [black] <Insert color>.
- E. Glass: As specified in [Section 088000 "Glazing."] [Section 088113 "Decorative Glass Glazing."] [Section 088400 "Plastic Glazing."]
- F. Door Hardware: [As selected by Architect from manufacturer's full range.] [As specified in Section 087100 "Door Hardware."] [As specified in Section 087111 "Door Hardware (Descriptive Specification)."] <Insert requirement.>

2.3 FABRICATION

- A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.
- B. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in [Section 087100 "Door Hardware."] [Section 087111 "Door Hardware (Descriptive Specification)."]
 - 1. Locate hardware cutouts and reinforcements as required by fire-rated label for assembly.
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
 - 1. Locate removable stops on the inside of spaces accessed by keyed doors.
- D. Fabricate components to allow secure installation without exposed fasteners.

2.4 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- D. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than [50] [70] percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.
 - 1. At fire-protection-rated openings, install fire-rated frames according to NFPA 80[and NFPA 105].
- B. Install frame components in the longest possible lengths with no piece less than **48 inches**; components **[72 inches]** **[96 inches]** **<Insert dimension>** or shorter must be one piece.
 - 1. Fasten to suspended ceiling grid on maximum **[48-inch]** **<Insert number>** centers, using sheet metal screws or other fasteners approved by frame manufacturer.
 - 2. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
 - 3. Secure clips to extruded main-frame components and not to snap-in or trim members.
 - 4. Do not leave screws or other fasteners exposed to view when installation is complete.
- C. Glass: Install glass according to [Section 088000 "Glazing" and] [Section 088113 "Decorative Glass Glazing" and] [Section 088400 "Plastic Glazing" and] aluminum-frame manufacturer's written instructions.
- D. Doors: Install doors aligned with frames and fitted with required hardware.
- E. Door Hardware: Install according to [Section 087100 "Door Hardware" and] [Section 087111 "Door Hardware (Descriptive Specification)" and] aluminum-frame manufacturer's written instructions.

3.3 ADJUSTING

- A. Inspect installation, correct misalignments, and tighten loose connections.
- B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.
- C. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 and AAMA 610.
- D. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepaired surface[**so touchup is not visible from a distance of 48 inches**] as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 081216

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Access doors and frames.~~
- ~~2. Fire-rated access doors and frames.~~

~~B. Related Requirements:~~

- ~~1. Section 077200 "Roof Accessories" for roof hatches.~~
- ~~2. Section 083113.53 "Security Access Doors and Frames" for access doors and frames for security applications.~~
- ~~3. Section 083123 "Floor Doors" for doors installed in floors.~~
- ~~4. Section 233300 "Air Duct Accessories" for heating and air-conditioning duct access doors.~~

1.2 ALLOWANCES

- A. Access doors and frames are part of an access door and frame allowance.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details[, **fire ratings**,] material descriptions, dimensions of individual components and profiles, and finishes.

- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum **6 by 6 inches** in size.

- C. Product Schedule: For access doors and frames. [**Use same designations indicated on Drawings.**]

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspecting agency.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

1.5 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.6 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies meets 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection[and temperature-rise limit] ratings indicated, according to NFPA 252 or UL 10B.

2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum **G60** or **A60** metallic coating.
- D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, **[Type 304] [Type 316]**. Remove tool and die marks and stretch lines, or blend into finish.
- E. Stainless Steel Flat Bars: ASTM A666, **[Type 304] [Type 316]**. Remove tool and die marks and stretch lines, or blend into finish.
- F. Aluminum Extrusions: **ASTM B221**, Alloy 6063.
- G. Aluminum Sheet: **ASTM B209**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- H. Frame Anchors: Same material as door face.
- I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 2. Keys: Furnish two keys per lock and key all locks alike.
 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in [Section 087100 "Door Hardware."] [Section 087111 "Door Hardware (Descriptive Specification)."]
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of **1 mil** for topcoat.
 - a. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors] <Insert color>.
- E. Stainless Steel Finishes:
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: **[Owner will engage] [Engage]** a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- 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 access door indicating compliance with each item listed in **[NFPA 80]** **[and] [NFPA 101]**.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes aluminum windows for exterior locations.
- B. Related Requirements:
 - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
 - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
 - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
 - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.3 ACTION SUBMITTALS

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

1. Exposed Finishes: [2 by 4 inches] <Insert dimensions>.
2. Exposed Hardware: Full-size units.

F. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. 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 mockup of typical wall area as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.
 2. Warranty Period:
 - a. Window: [10] <Insert number> years from date of Substantial Completion.

- b. Glazing Units: [Five] [10] [20] <Insert number> years from date of Substantial Completion.
- c. Aluminum Finish: [10] [20] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: [R] [LC] [CW] [AW] [As indicated on Drawings] <Insert class>.
 - 2. Minimum Performance Grade: [15] [20] [25] [30] [35] [40] [45] [50] [As indicated on Drawings] <Insert grade>.
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [0.30 Btu/sq. ft. x h x deg F] [0.32 Btu/sq. ft. x h x deg F] [0.35 Btu/sq. ft. x h x deg F] [0.60 Btu/sq. ft. x h x deg F] <Insert value>.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of [0.40] [0.30] [0.27] <Insert value>.
- E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of [45] [52] <Insert value>.
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: [120 deg F ambient; 180 deg F material surfaces] <Insert temperature change>.
- G. Sound Transmission Class (STC): Rated for not less than [26] [30] <Insert rating> STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.
- H. Outside-Inside Transmission Class (OITC): Rated for not less than [22] [26] [30] <Insert rating> OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.
- I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [1] [2] [3] [4] for [basic] [enhanced] protection.
 - 1. Large-Missile Test: For glazing located within [30 feet] <Insert dimension> of grade.
 - 2. Small-Missile Test: For glazing located between [30 feet] and [60 feet] <Insert dimension> above grade.

2.3 ACCESSORIES

- A. Integral Ventilating System/Device: Where indicated, provide weather-stripped, adjustable, horizontal fresh-air vent, with a free airflow slot, full width of window sash by approximately [1 inch] [3 inches] when open, complying with AAMA/WDMA/CSA 101/I.S.2/A440. Equip vent bar with an integral insect screen, removable for cleaning.
- B. Dividers (False Muntins): Provide extruded-aluminum divider grilles in designs indicated for each sash lite.
 - 1. Type: [Permanently located at exterior lite] [Permanently located between insulating-glass lites] <Insert type>.
 - 2. Pattern: [As indicated on Drawings] <Insert pattern>.
 - 3. Profile: [As selected by Architect from manufacturer's full range] <Insert profile>.
- C. Horizontal Louver Blinds: Provide manufacturer's standard, removable, horizontal louver blinds with aluminum slats and polyester fiber cords that are operated by hardware located on inside face of sash.
 - 1. Operation: [Tilt only] [Tilt, raising, and lowering].
 - 2. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- D. Subsills: [Thermally broken] [Nonthermal], extruded-aluminum subsills in configurations indicated on Drawings.
- E. Column Covers: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- F. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- G. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- H. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.4 INSECT SCREENS

- A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
 - 1. Type and Location: [Full, inside for outswing] [Full, inside for projected, awning] [Full, outside for inswing] [Full, outside for projected, hopper] [Full, outside for double-hung] [Half, outside for single-hung] [Full, outside for sliding] [Half, outside for sliding] sashes.
- B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
 - 1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
- C. Glass-Fiber Mesh Fabric: [18-by-14 or 18-by-16] [20-by-20 or 20-by-30] <Insert type> mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.
 - 1. Mesh Color: [Manufacturer's standard] <Insert color>.

- D. Aluminum Wire Fabric: **18-by-16** mesh of **0.011-inch** diameter, coated aluminum wire.

1. Wire-Fabric Finish: [Natural bright] [Charcoal gray] [Black] <Insert finish>.

2.5 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.
- F. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.
- G. [Bow] [Bay] Window Assemblies: Provide [operating] [and] [fixed] units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
1. Angled mullion posts with interior and exterior trim.
 2. Angled interior and exterior extension and trim.
 3. Exterior head and sill casings and trim.
- H. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.6 GENERAL FINISH REQUIREMENTS

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

2.7 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
- D. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
 - 1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- E. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - 1. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- F. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic or polyester enamel primer/topcoat system complying with AAMA 2603[, **except with a minimum dry film thickness of 1.5 mils**], medium gloss.
 - 2. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities] <Insert color>.
- G. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- H. Superior-Performance Organic Finish: [Two] [Three] [Four]-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
 - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
 - 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
 - 2. Air-Infiltration Testing:
 - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
 - b. Allowable Air-Leakage Rate: **[1.5]** **<Insert number>** times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
 - 3. Water-Resistance Testing:
 - a. Test Pressure: **[Two-thirds]** **<Insert number>** times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
 - 4. Testing Extent: **[Three]** **[Three mockup]** **<Insert number or description>** windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
 - 5. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

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

END OF SECTION 085113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Hinges.~~
- ~~2. Self-closing hinges and pivots.~~
- ~~3. Center-hung and offset pivots.~~
- ~~4. Continuous, pin-and-barrel-type hinges.~~
- ~~5. Continuous, gear-type hinges.~~
- ~~6. Concealed hinges.~~
- ~~7. Bored locks.~~
- ~~8. Mortise locks.~~
- ~~9. Interconnected locks.~~
- ~~10. Roller latches.~~
- ~~11. Push-pull latches.~~
- ~~12. Bored auxiliary locks.~~
- ~~13. Mortise auxiliary locks.~~
- ~~14. Narrow stile auxiliary locks.~~
- ~~15. Push-button combination locks.~~
- ~~16. Electric strikes.~~
- ~~17. Electromagnetic locks.~~
- ~~18.1. Delayed-egress electromagnetic locks.~~
- ~~19. Electromechanical locks.~~
- ~~20. Self-contained electronic locks.~~
- ~~21. Exit locks and alarms.~~
- ~~22. Surface bolts.~~
- ~~23. Manual flush bolts.~~
- ~~24. Automatic flush bolts.~~
- ~~25. Self-latching flush bolts.~~
- ~~26. Exit devices and auxiliary items.~~
- ~~27. Lock cylinders.~~
- ~~28. Key control cabinet.~~
- ~~29. Key lock boxes.~~
- ~~30. Key control system software.~~
- ~~31. Operating trim.~~
- ~~32.2. Coordinators.~~
- ~~33.3. Carry-open bars.~~
- ~~34.4. Astragals.~~
- ~~35. Surface closers.~~
- ~~36. Concealed closers.~~
- ~~37. Closer holder release devices.~~
- ~~38. Wall and floor-mounted stops.~~

- 39. — Electromagnetic door holders.
- 40. — Overhead stops and holders.
- 41. — Door gasketing.
- 42. — Thresholds.
- 43. — Sliding door hardware.
- 44. — Folding door hardware.
- 45. — Metal protective trim units.
- 46. — Plastic protection plates.
- 47. — Auxiliary door hardware.
- 48. — Auxiliary electrified door hardware.

B. — Related Requirements:

- 1. — ~~[Section 064113 "Wood-Veneer-Faced Architectural Cabinets"] [and] [Section 064116 "Plastic-Laminate-Clad Architectural Cabinets"]~~ for cabinet door hardware provided with cabinets.
- 2. — Section 081113 "Hollow Metal Doors and Frames" ~~[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of hollow metal frames].~~
- 3. — Section 081119 "Stainless-Steel Doors and Frames" ~~[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of stainless steel frames].~~
- 4. — Section 081173 "Sliding Metal Fire Doors" for door and track preparation, reinforcement, and motorized operators provided as part of automatic-closing assemblies.
- 5. — Section 081213 "Hollow Metal Frames" ~~[for astragals provided as part of labeled fire-rated assemblies] [and] [for door silencers provided as part of hollow metal frames].~~
- 6. — Section 081216 "Aluminum Frames" for door silencers provided as part of aluminum frames.
- 7. — Section 081316.13 "Aluminum Terrace Doors" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 8. — Section 081416 "Flush Wood Doors" for ~~[astragals] [and] [integral intumescent seals]~~ provided as part of labeled fire-rated assemblies.
- 9. — Section 081433 "Stile and Rail Wood Doors" for ~~[astragals] [and] [integral intumescent seals]~~ provided as part of labeled fire-rated assemblies.
- 10. — Section 081713 "Integrated Metal Door Opening Assemblies" for door hardware provided as part of integrated metal door opening assemblies.
- 11. — Section 083113 "Access Doors and Frames" for access door hardware, ~~[except] [including]~~ cylinders.
- 12. — Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
- 13. — Section 083326 "Overhead Coiling Grilles" for door hardware provided as part of overhead coiling grille assemblies.
- 14. — ~~[Section 083473.13 "Metal Sound Control Door Assemblies"] [and] [Section 083473.16 "Wood Sound Control Door Assemblies"]~~ for hinges and gasketing provided as part of sound-rated door assemblies.
- 15. — Section 083513 "Folding Doors" for pulls, latches, hinges, guides, and pivots provided as part of the folding door package.
- 16. — Section 084113 "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 17. — Section 084126 "All-Glass Entrances and Storefronts" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 18. — Section 084229.13 "Folding Automatic Entrances" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 19. — Section 084229.23 "Sliding Automatic Entrances" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 20. — Section 084229.33 "Swinging Automatic Entrances" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 21. — Section 084233 "Revolving Door Entrances" for revolving door entrance hardware, ~~[except] [including]~~ cylinders.
- 22. — Section 084243 "Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances" for entrance door hardware, ~~[except] [including]~~ cylinders.
- 23. — Section 087113 "Power Door Operators" for low-energy power operators and low-energy power-assist operators.
- 24. — Section 102213 "Wire Mesh Partitions" for door hardware for doors in wire mesh partitions, ~~[except] [including]~~ cylinders.
- 25. — Section 102600 "Wall and Door Protection" for plastic door protection units that match wall protection units.
- 26. — Section 119812 "Detention Doors and Frames" for door silencers provided as part of detention frames.

- ~~27. Section 119814 "Detention Door Hardware" for hardware for detention doors.~~
- ~~28. Section 133419 "Metal Building Systems" for door hardware, ~~[except]~~ **[including]** cylinders.~~
- ~~29. Section 134900 "Radiation Protection" for lead-lined astragals provided as part of labeled fire-rated assemblies.~~
- ~~30. Section 281000 "Access Control" for coordination of access control system components.~~
- ~~31. Section 281400 "Access Control System Hardware" for access control system units, power, battery chargers, and computer equipment.~~
- ~~32. Section 283100 "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.~~
- ~~33. Section 284621.11 "Addressable Fire Alarm Systems" for connections to building fire alarm system.~~
- ~~34. Section 284621.13 "Conventional Fire Alarm Systems" for connections to building fire alarm system.~~

1.2 ALLOWANCES

- A. Door hardware is part of **[Door Hardware Allowance]** **<Insert allowance>**.

1.3 COORDINATION

- A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.
 - 1. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- 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 hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field-verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.
 - 1. Conference participants must include Installer's Architectural Hardware Consultant **[and Owner's security consultant]**.
- B. Keying Conference: Conduct conference at **[Project site]** **<Insert location>**.
 - 1. Conference participants must include Installer's Architectural Hardware Consultant **[and Owner's security consultant]**.
 - 2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system, including, but not limited to, the following:
 - a. Flow of traffic and degree of security required.
 - b. Preliminary key system schematic diagram.

- c. Requirements for key control system.
- d. Requirements for access control.
- e. Address for delivery of keys.
- f. <Insert requirements to suit Project>.

1.5 ACTION SUBMITTALS

A. Product Data:

- 1. Hinges.
- 2. Self-closing hinges and pivots.
- 3. Center-hung and offset pivots.
- 4. Continuous, pin-and-barrel-type hinges.
- 5. Continuous, gear-type hinges.
- 6. Concealed hinges.
- 7. Bored locks.
- 8. Mortise locks.
- 9. Interconnected locks.
- 10. Roller latches.
- 11. Push-pull latches.
- 12. Bored auxiliary locks.
- 13. Mortise auxiliary locks.
- 14. Narrow-stile auxiliary locks.
- 15. Push-button combination locks.
- 16. Electric strikes.
- 17. Electromagnetic locks.
- 18. Delayed-egress electromagnetic locks.
- 19. Electromechanical locks.
- 20. Self-contained electronic locks.
- 21. Exit locks and alarms.
- 22. Surface bolts.
- 23. Manual flush bolts.
- 24. Automatic flush bolts.
- 25. Self-latching flush bolts.
- 26. Exit devices and auxiliary items.
- 27. Lock cylinders.
- 28. Key control cabinet.
- 29. Key lock boxes.
- 30. Key control system software.
- 31. Operating trim.
- 32. Coordinators.
- 33. Carry-open bars.
- 34. Astragals.
- 35. Surface closers.
- 36. Concealed closers.
- 37. Closer holder release devices.
- 38. Wall- and floor-mounted stops.
- 39. Electromagnetic door holders.

40. Overhead stops and holders.
 41. Door gasketing.
 42. Thresholds.
 43. Sliding door hardware.
 44. Folding door hardware.
 45. Metal protective trim units.
 46. Plastic protection plates.
 47. Auxiliary door hardware.
 48. Auxiliary electrified door hardware.
 49. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Data Submittals: For each product.
- C. Shop Drawings: For electrified door hardware.
1. Include diagrams for power, signal, and control wiring.
 2. Include details of interface of electrified door hardware and building safety and security systems.
- D. Samples: For each exposed product in each finish specified, in manufacturer's standard size.
1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- E. Samples for Initial Selection: For each type of exposed finish.
- F. Samples for Verification: For each type of exposed product, in each finish specified.
1. Sample Size: Full-size units or minimum **2-by-4-inch** Samples for sheet and **4-inch** long Samples for other products.
 - a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
 2. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- G. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Submittal Sequence: Submit door hardware schedule **[after]** **[or]** **[concurrent with]** submissions of product data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 2. Format: Use same scheduling sequence and format **[and use same door numbers]** as in door hardware schedule in the Contract Documents.
 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.

- f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
- g. Mounting locations for door hardware.
- h. List of related door devices specified in other Sections for each door and frame.

- H. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [and] [Architectural Hardware Consultant].
- B. Product Certificates: For each type of electrified door hardware.
 - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final [door hardware] [and] [keying] schedule.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Door Hardware: <Insert detailed descriptions and specific numbers of units>.
 - 2. Electrical Parts: <Insert detailed descriptions and specific numbers of units>.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.

3. 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.

B. Architectural Hardware Consultant Qualifications: A 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 who is currently certified by DHI as **[a Door and Hardware Specification Consultant (DHSC)] [an Architectural Hardware Consultant (AHC)] [an Architectural Hardware Consultant (AHC) and an Electrified Hardware Consultant (EHC)] [an Architectural Opening Consultant (AOC)]**.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lockup for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys **[and permanent cores]** to Owner by registered mail or overnight package service.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures, including excessive deflection, cracking, or breakage.
- b. Faulty operation of doors and door hardware.
- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: **[Three]** **<Insert number>** years from date of Substantial Completion unless otherwise indicated below:

- a. Electromagnetic and Delayed-Egress Locks: **[Five]** **<Insert number>** years from date of Substantial Completion.
- b. Exit Devices: **[Two]** **<Insert number>** years from date of Substantial Completion.
- c. Manual Closers: **[10]** **<Insert number>** years from date of Substantial Completion.
- d. Concealed Floor Closers: **[Five]** **[10]** **[25]** **<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of door hardware from single manufacturer.

- 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.
 - 1. Air-Leakage Rate: Maximum air leakage of **[0.3 cfm per sq. ft.]** <Insert rate> at the tested pressure differential of **[0.3 inch wg]** <Insert value> of water.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Means of Egress Doors: Latches do not require more than **15 lbf** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with **[the USDOJ's "2010 ADA Standards for Accessible Design"]** **[the DOT's "ADA Standards for Transportation Facilities"]** **[the ABA standards of the Federal agency having jurisdiction]** **[ICC A117.1]** **[HUD's "Fair Housing Accessibility Guidelines"]** **[and]** <Insert regulation>.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf**.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf** applied perpendicular to door.
 - b. Sliding or Folding Doors: **5 lbf** applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch** high.
 - 4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
 - 5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 ~~MECHANICAL LOCKS AND LATCHES~~

- A. ~~Lock Functions: As indicated in door hardware schedule.~~
- B. ~~Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:~~
 - 1. ~~Bored Locks: Minimum 1/2-inch latchbolt throw.~~
 - 2. ~~Mortise Locks: Minimum 3/4-inch latchbolt throw.~~
 - 3. ~~Deadbolts: Minimum [1-inch] [1.25-inch] <Insert dimension> bolt throw.~~
- C. ~~Lock Backset: 2-3/4 inches unless otherwise indicated.~~
- D. ~~Lock Trim:~~

1. Description: ~~[As indicated on Drawings]~~ ~~<Insert description or manufacturer's design designation>~~.
2. Levers: ~~[Wrought]~~ ~~[Forged]~~ ~~[Cast]~~.

a. ~~<Insert model number and description>~~.

3. Escutcheons (Roses): ~~[Wrought]~~ ~~[Forged]~~ ~~[Cast]~~.
4. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

2.4 LOCK CYLINDERS

A. Standard Lock Cylinders: ANSI/BHMA A156.5, ~~[Grade 1]~~ ~~[Grade 1A]~~ ~~[Grade 2]~~ permanent cores; face finished to match lockset.

1. Core Type: ~~[Interchangeable]~~ ~~[Removable]~~.

B. High-Security Lock Cylinders: ANSI/BHMA A156.30, ~~[Grade 1]~~ ~~[Grade 2]~~ ~~[Grade 3]~~ permanent cores that are removable; face finished to match lockset.

1. ~~[Type M, mechanical]~~ ~~[Type E, electrical]~~.

C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.52.3 KEYING

A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, appendix. Provide one extra key blank for each lock. **[Incorporate decisions made in keying conference.]**

1. No Master Key System: Only change keys operate cylinders.
 - a. Provide three cylinder change keys.
2. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three cylinder change keys and five master keys.
3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
 - a. Provide three cylinder change keys and five each of master and grand master keys.

4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
 - a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.
 5. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
 6. Keyed Alike: Key all cylinders to same change key.
- B. Keys: **[Nickel silver]** **[Brass]**.
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: **["DO NOT DUPLICATE."] [Information to be furnished by Owner.]**

2.62.4 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: ANSI/BHMA A156.3; consisting of active-leaf, hold-open lever, and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release[; **and with internal override**].
- B. Carry-Open Bars: ANSI/BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: ANSI/BHMA A156.22.

~~2.7~~ ~~DOOR GASKETING~~

- ~~A. Maximum Air Leakage: When tested in accordance with ASTM E283/E283M with tested pressure differential of **0.3 inch wg**, as follows:~~
- ~~1. Smoke-Rated Gasketing: **0.3 cfm/sq. ft.** of door opening.~~
 - ~~2. Gasketing on Single Doors: **0.3 cfm/sq. ft.** of door opening.~~
 - ~~3. Gasketing on Double Doors: **0.50 cfm per ft.** of door opening.~~

2.82.5 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.
 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.

- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames [~~use threaded-to-the-head wood screws for wood doors and frames~~].
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
 - 3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.92.6 FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights **[indicated on Drawings]** **[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's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every **30 inches** of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every **30 inches** of door height greater than **90 inches**.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as **[indicated in keying schedule]** **[directed by Owner]**.
 - 2. Furnish permanent cores to Owner for installation.
- F. Key Control System:
 - 1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
 - 2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.
 - 3. Key Control System Software: Set up multiple-index system based on final keying schedule.
- G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, **[above accessible ceilings]** **[in equipment room]**. Verify location with Architect.

1. Configuration: Provide **[one power supply for each door opening]** **[least number of power supplies required to adequately serve doors]** with electrified door hardware.
- H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- I. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- J. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

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

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
 3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
- B. Occupancy Adjustment: Approximately **[three]** **[six]** **<Insert number>** months after date of Substantial Completion, Installer's Architectural Hardware Consultant is to examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.

- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service is to include [six] [nine] [12] <Insert number> months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. [Engage Installer to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

- A. Hardware Set 1: Each door to have the following:
 - 1. <Insert hardware type>.

END OF SECTION 087100

SECTION 089116 - OPERABLE WALL LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Operable, [~~extruded-aluminum~~] [~~and~~] [~~formed-metal~~] louvers.
2. Operable, [~~extruded-aluminum~~] [~~and~~] [~~formed-metal~~] insulated louvers.
3. Blank-off panels for louvers.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for field painting exterior louvers.
2. Section 099123 "Interior Painting" for field painting interior louvers.
3. Section 221513 "General-Service Compressed-Air Piping" for connecting pneumatic-operated louvers.

1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 ACTION 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. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.

8. Environmental Product Declaration: For each product.
 9. Third-Party Certifications: For each product.
 10. Third-Party Certified Life Cycle Assessment: For each product.
 11. Environmental Product Declaration: For each product.
 12. Health Product Declaration: For each product.
 13. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 14. Environmental Product Declaration: For each product.
 15. Environmental Product Declaration: For each product.
 16. Environmental Product Declaration: For each product.
 17. Third-Party Certifications: For each product.
 18. Third-Party Certified Life Cycle Assessment: For each product.
- C. 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, flashings, sealants, and other means of preventing water intrusion.
 2. Show mullion profiles and locations.
 3. Wiring Diagrams: For power, signal, and control wiring for motorized operable louvers.
- D. Samples: For each type of metal finish required.
- E. Delegated Design Submittal: For louvers indicated to comply with structural [**and seismic**] performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with 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.
- B. Sample Warranties: For manufacturer's special warranties.

1.5 QUALITY ASSURANCE

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

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

- A. 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. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: **[Five]** **[10]** **[20]** **<Insert number>** years from date of Substantial Completion.
- B. 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. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: **[Five]** **[10]** **<Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain operable **[and fixed]** louvers from single source from single manufacturer **[where indicated to be of same type, design, or factory-applied color finish]**.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural **[and seismic]** performance requirements and design criteria indicated.
- B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures to the face of the building are considered to act normal.
1. Wind Loads:
 - a. Determine loads based on pressures as indicated on Drawings.
 - b. Determine loads based on a uniform pressure of **[20 lbf/sq. ft.]** **[30 lbf/sq. ft.]** **<Insert value>**, acting inward or outward.
 - c. Determine loads based on pressures indicated below:

- 1) Corner Zone: Within **<Insert distance>** of building corners, uniform pressure of **<Insert design wind pressure>**, acting inward, and **<Insert design wind pressure>**, acting outward.
 - 2) Other Than Corner Zone: Uniform pressure of **<Insert design wind pressure>**, acting inward, and **<Insert design wind pressure>**, acting outward.
- C. Seismic Performance:
1. As indicated on Drawings.
 2. Louvers, including attachments to other construction, withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7] **<Insert requirement>**.
 - a. Design earthquake spectral response acceleration, short period (Sds) for Project is **<Insert value>**.
 - b. Component Importance Factor: [1.5] [1.0].
- D. 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 in accordance with AMCA 500-L.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): [120 deg F, ambient; 180 deg F, material surfaces] **<Insert temperature range>**.
- F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- G. 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.

2.3 OPERABLE EXTRUDED-ALUMINUM LOUVERS

- A. Louver Construction and Operation: Provide operable louvers with extruded aluminum frames and blades of not less than **0.080-inch** nominal thickness, and with operating mechanisms to suit louver sizes.
1. Hand operation with push bars.
 2. Crank operation with removable crank operator in sill or jamb.
 3. Chain operation with tension spring, wall clip, pull chain, and **160 deg F** fusible link.
 4. Motor operation with [two-position, spring return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch] [two-direction, 110-V, 60-Hz motor and limit switches]; equipped with [frame-mounted switch] [remote-mounted switch with indicator light] [terminals for controlling devices].
 5. Pneumatic piston operation for use with **80- to 100-psi** compressed air for [two-position] [modulating] operation; power open, power close [with spring return fail-safe].

2.4 OPERABLE FORMED-METAL LOUVERS

- A. Louver Operation: Provide operable louvers with operating mechanisms to suit louver sizes.
1. Hand operation with push bars.
 2. Crank operation with removable crank operator in sill or jamb.
 3. Chain operation with tension spring, wall clip, pull chain, and **160 deg F** fusible link.

4. ~~Motor operation with [two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch] [two-direction, 110-V, 60-Hz motor and limit switches]; equipped with [frame-mounted switch] [remote-mounted switch with indicator light] [terminals for controlling devices].~~
5. ~~Pneumatic piston operation for use with 80- to 100-psi compressed air for [two-position] [modulating] operation; power open, power close [with spring-return fail-safe].~~

2.5 OPERABLE INSULATED LOUVERS

A. ~~Louver Operation: Provide operable louvers with operating mechanisms to suit louver sizes.~~

1. ~~Hand operation with push bars.~~
2. ~~Crank operation with removable crank operator in sill or jamb.~~
3. ~~Chain operation with tension spring, wall clip, pull chain, and 160 deg F fusible link.~~
4. ~~Motor operation with [two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch] [two-direction, 110-V, 60-Hz motor and limit switches]; equipped with [frame-mounted switch] [remote-mounted switch with indicator light] [terminals for controlling devices].~~
5. ~~Pneumatic piston operation for use with 80- to 100-psi compressed air for [two-position] [modulating] operation; power open, power close [with spring-return fail-safe].~~

2.6.2.3 LOUVER SCREENS

A. General: Provide screen at **[each exterior louver]** **[louvers indicated]**.

1. Screen Location: **[Interior]** **[Exterior]** face unless otherwise indicated.
2. Screening Type: **[Bird screening]** **[Bird screening, except where insect screening is indicated]** **[Insect screening]**.

B. Secure screen frames to louver frames with **[stainless steel machine screws]** **[machine screws with heads finished to match louver]**, spaced a maximum of **6 inches** from each corner and at **12 inches** o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. **[Reinforce extruded-aluminum screen frames at corners with clips.]**
2. Finish: **[Same finish as louver frames to which louver screens are attached]** **[Mill finish unless otherwise indicated]**.
3. Type: **[Rewirable frames with a driven spline or insert]** **[Non-rewirable, U-shaped frames]**.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening, Aluminum: **1/2-inch-** square mesh, **0.063-inch** wire.
2. Bird Screening, Stainless Steel: **1/2-inch-** square mesh, **0.047-inch** wire.
3. Bird Screening, Flattened, Expanded Aluminum: **3/4 by 0.050 inch** thick.
4. Insect Screening, Aluminum: **18-by-16** mesh, **0.012-inch** wire.
5. Insect Screening, Stainless Steel: **18-by-18** mesh, **0.009-inch** wire.

E. Louver Screening for Galvanized-Steel Louvers:

1. Bird Screening, Galvanized Steel: **1/2-inch-** square mesh, **0.041-inch** wire.
2. Bird Screening, Stainless Steel: **1/2-inch-** square mesh, **0.047-inch** wire.

3. Insect Screening, Galvanized Steel: **18-by-14** mesh, **0.011-inch** wire.
4. Insect Screening, Stainless Steel: **18-by-18** mesh, **0.009-inch** wire.

F. Louver Screening for Stainless Steel Louvers:

1. Bird Screening, Stainless Steel: **1/2-inch** square mesh, **0.047-inch** wire.
2. Insect Screening, Stainless Steel: **18-by-18** mesh, **0.009-inch** wire.

2.72.4 BLANK-OFF PANELS

A. Uninsulated Blank-Off Panels: Metal sheet attached to back of louver.

1. Aluminum sheet for aluminum louvers, not less than **0.050-inch** nominal thickness.
2. Galvanized-steel sheet for galvanized-steel louvers, not less than **[0.040-inch] [0.052-inch]** nominal thickness.
3. Stainless steel sheet for stainless steel louvers, not less than **[0.038-inch] [0.050-inch]** nominal thickness, with grain running in same direction as grain of louver blades.
4. Panel Finish: **[Same finish applied to louvers] [Same finish type applied to louvers, but black color]**.
5. Attach blank-off panels with **[clips] [sheet metal screws]** <Insert method>.

B. Insulated Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: **[1 inch] [2 inches]**.
2. Metal Facing Sheets, Aluminum: Not less than **0.032-inch** nominal thickness.
3. Metal Facing Sheets, Galvanized-Steel Sheet: Not less than **0.028-inch** nominal thickness.
4. Metal Facing Sheets, Stainless Steel Sheet: Not less than **0.031-inch** nominal thickness.
5. Insulating Core: **[Rigid, glass-fiber-board insulation] [or] [extruded-polystyrene foam]** <Insert insulation material>.
6. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard **[extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness] [channel frames]**, with corners mitered and with same finish as panels.
7. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
8. Panel Finish: **[Same finish applied to louvers] [Same finish type applied to louvers, but black color]**.
9. Attach blank-off panels with **[clips] [sheet metal screws]** <Insert method>.

2.82.5 MATERIALS

- A. Aluminum Extrusions: **ASTM B221**, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: **ASTM B209**, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, **[G60] [G90]** zinc coating, mill phosphatized.
- D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, **[No. 2B finish] [No. 2D finish] [No. 4 finish, with grain running parallel to length of blades and frame members] [No. 4 finish, with grain running perpendicular to length of blades and frame members] [No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members] [No. 6 finish]**.
- E. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use [Phillips flat-head] [hex-head or Phillips pan-head] [tamper-resistant] 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.
- F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.
- I. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] [50] <Insert value> percent.
- J. Regional Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- K. Regional Materials: Products shall be manufactured within 500 miles of Project site.
- L. Regional Materials: Products shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- M. Indigenous Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- N. Regional Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.92.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern [unless horizontal mullions are indicated] [where indicated].
 2. Horizontal Mullions: Provide horizontal mullions at joints [unless continuous vertical assemblies are indicated] [where indicated].
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation

tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: **[Channel]** **[Exterior flange]** **[Interior flange]** unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or **72 inches** o.c., whichever is less.
- F. Provide **[subsills made of same material as louvers]** **[or]** **[extended sills]** for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds **[concealed from view]** **[, threaded fasteners, or both, as standard with louver manufacturer]** unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.102.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm]** **[AA-M12C22A31, Class II, 0.010 mm]** or thicker.
- C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm]** **[AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.
 1. Color: **[Champagne]** **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors and color densities]** **<Insert color>**.
- D. Conversion-Coated Finish: AA-C12C42, nonetched, cleaned with inhibited chemicals, and chemical conversion coated with acid chromate-fluoride-phosphate.
- E. Factory-Primed Finish: AA-C12C42R1x with air-dried primer of not less than **2-mil** dry film thickness.
- F. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color and gloss>**.
- G. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604]** **[AAMA 2605]** and containing not less than **[50]** **[70]** percent PVDF resin by weight in color coat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[for seacoast and severe environments]**.
 2. Color and Gloss: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from manufacturer's full range]** **<Insert color and gloss>**.
- H. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written

- instructions [for seacoast and severe environments].
2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- I. Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions [for seacoast and severe environments].
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- J. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
- K. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.
1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 2. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.112.8 GALVANIZED-STEEL SHEET FINISHES

- A. Finish louvers after assembly.
- B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils**.
1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

2.122.9 STAINLESS STEEL SHEET FINISHES

- A. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

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 of the Work.
- 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 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. Protect unpainted galvanized- and nonferrous-metal surfaces that are 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.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Test operable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed louver surfaces 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 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 089116

SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation.

1.2 ALLOWANCES

- A. Concrete MVE-control systems are part of [Moisture Vapor Emission Control Allowance] <Insert allowance>.**

1.3 UNIT PRICES

- A. Work of this Section is affected by [Moisture Vapor Emission Control Unit Price] <Insert unit price>.**

1.4 DEFINITIONS

- A. MVE:** Moisture vapor emission.
- B. MVER:** Moisture vapor emission rate.

1.5 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.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data:** For [Installer] [manufacturer].
- B. Product Test Reports:** For each MVE-control system, for tests performed by [manufacturer and witnessed by a qualified testing agency] [a qualified testing agency].
- C. Preinstallation testing reports.**

- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
 - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than **65 deg F** and not more than **85 deg F** at least 48 hours before use.
 - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than **65 deg F** or more than **85 deg F** and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
 - 3. Install MVE-control systems where concrete surface temperatures will remain a minimum of **5 deg F** higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 - 1. MVER: Maximum [**15 lb of water/1000 sq. ft.**] [**25 lb of water/1000 sq. ft.**] [**30 lb of water/1000 sq. ft.**] <Insert rate> when tested according to ASTM F1869.
 - 2. Relative Humidity: Maximum [**100**] [**90**] <Insert number> percent when tested according to ASTM F2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum [**0.10 perm**] [**0.02 perm**] [**0.06 perm**] when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than [**200 psi**] <Insert pressure> with failure in the concrete according to ASTM D7234.

2.2 ACCESSORIES

- A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of [3000-psi] <Insert pressure> compressive strength after 28 days when tested according to ASTM C109/C109M.
- B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.
- C. Cementitious Underlayment: If required to maintain manufacturer's warranty, provide MVE-control system manufacturer's [gypsum] [hydraulic] cement-based underlayment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Preinstallation Testing:
 - 1. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests.
 - 2. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE-control system in areas where pH readings are less than [7.0] <Insert value> and in areas where pH readings are greater than [8.5] <Insert value>.
 - 3. Moisture Testing: Perform tests so that each test area does not exceed [200 sq. ft.] [1000 sq. ft.] <Insert dimension>, 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. Install MVE-control system in locations where concrete substrate MVER exceeds [3 lb of water/1000 sq. ft.] <Insert rate> in 24 hours.
 - b. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than [75] <Insert number> percent.
 - 4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum [100-sq. ft.] <Insert dimension> area of MVE-control system to prepared concrete substrate and test according to ASTM D7234.
 - a. Proceed with installation only where tensile bond strength is greater than [200 psi] <Insert pressure> with failure in the concrete.
- B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.

1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
 2. Provide concrete surface profile complying with ICRI 310.2R [CSP 3] <Insert requirements> by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
 4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
 5. Fill surface depressions and irregularities with patching and leveling material.
 6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
 7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
 8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.
- C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION

- A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
1. Install primers as required to comply with manufacturer's written instructions.
- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.
- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.
- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.
- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.
- F. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform installation inspections.
- B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
1. Verify that surface preparation meets requirements.
 2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
 3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to

manufacturer's written instructions.

- C. MVE-control system will be considered defective if it does not pass inspections.

3.5 PROTECTION

- A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.
- B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 090561.13

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

~~1. Gypsum board shaft wall assemblies.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each component of gypsum board shaft wall assembly.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 DELIVERY, STORAGE, AND HANDLING

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

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.

- B. Do not install finish panels until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular

- shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 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: Provide materials and construction identical to those of assemblies tested according to ASTM E90 and classified according to ASTM E413 by a testing and inspecting agency.
- C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.
- D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] ~~<Insert value>~~ percent.
- E. Regional Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- F. Regional Materials: Products shall be manufactured within **500 miles** of Project site.
- G. Regional Materials: Products shall be manufactured within **100 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- H. Indigenous Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- I. Regional Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

2.2 ~~GYPSUM BOARD SHAFT WALL ASSEMBLIES~~

- A. ~~Fire-Resistance Rating: [As indicated on Drawings] [1 hour] [2 hours] [3 hours] [4 hours] <Insert rating>.~~
- B. ~~STC Rating: [As indicated on Drawings] [51, minimum] <Insert rating>.~~
- C. ~~Gypsum Shaftliner Board:~~
- D. ~~Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.~~
1. ~~Protective Coating: [Coating with equivalent corrosion resistance of ASTM A653/A653M, G40] [ASTM A653/A653M, G40,~~

~~hot-dip galvanized] [ASTM A653/A653M, G60, hot-dip galvanized]~~ unless otherwise indicated.

- E. ~~Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:~~
 - 1. ~~Depth: [As indicated] [2-1/2 inches] [4 inches] [6 inches].~~
 - 2. ~~Minimum Base-Metal Thickness: [As indicated] [0.018 inch] [0.030 inch] [0.033 inch] <Insert value>.~~
- F. ~~Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least [2 inches] <Insert dimension> long and matching studs in depth.~~
 - 1. ~~Minimum Base-Metal Thickness: [As indicated] [Matching steel studs] [0.018 inch] [0.021 inch] [0.030 inch] [0.033 inch] <Insert value>.~~
- G. ~~Elevator Hoistway Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than [0.033 inch] <Insert dimension> thick.~~
- H. ~~Finish Panels: [As indicated.] [Gypsum board as specified in Section 092900 "Gypsum Board."] [Gypsum veneer plaster as specified in Section 092613 "Gypsum Veneer Plastering."] [Cementitious backer units as specified in Section 092900 "Gypsum Board."] [Cementitious backer units as specified in Section 093013 "Ceramic Tiling."] <Insert finish panels>.~~
- I. ~~Sound Attenuation Blankets: As specified in [Section 092900 "Gypsum Board."] [Section 092613 "Gypsum Veneer Plastering."]~~

2.32.2 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in [Section 092900 "Gypsum Board"] [Section 092613 "Gypsum Veneer Plastering"] that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
 - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.
- E. Reinforcing: Galvanized-steel reinforcing strips with [0.033-inch] <Insert dimension> minimum thickness of base metal (uncoated).
- F. Acoustical Sealant: Section 079219 "Acoustical Joint Sealants."
- G. Gypsum Board Cants:
 - 1. Gypsum Board Panels: As specified in Section 092900 "Gypsum Board," [Type X, 1/2- or 5/8-inch] <Insert requirements>

- panels.
- 2. Adhesive: Laminating adhesive as specified in Section 092900 "Gypsum Board."
- 3. Non-Load-Bearing Steel Framing: As specified in Section 092216 "Non-Structural Metal Framing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fire Protection."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
 - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
 - 2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated

construction.

- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints [at locations indicated on Drawings] [according to ASTM C840 and in specific locations approved by Architect] while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- I. Gypsum Board Cants: At projections into shaft [exceeding 4 inches] [where indicated], install gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
 - 2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.
- J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Framing systems.~~
- ~~2.1. Suspension systems.~~
- ~~3. Grid suspension systems.~~

~~B. Related Requirements:~~

- ~~1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.~~

1.2 ACTION SUBMITTALS

A. Product Data:

- 1. Framing systems.
- 2. Suspension systems.
- 3. Grid suspension systems.

B. Sustainable Design Submittals:

- 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- 2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For **[high-strength steel studs and tracks]** **[firestop tracks]** **[post-installed anchors]** **[and]** **[power-actuated fasteners]**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

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 Certified Steel Stud Association]** **[the Steel Framing Industry Association]** **[the Steel Stud Manufacturers Association]** **[or]** **[the Supreme Steel Framing System Association]**.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

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, in accordance with 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, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For ~~[composite]~~ ~~[non-composite]~~ wall assemblies, limited to ~~[1/240]~~ ~~[1/360]~~ of the wall height based on horizontal loading of ~~[5 lbf/sq. ft.]~~ ~~[10 lbf/sq. ft.]~~ ~~<Insert value>~~.
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or **5 lbf/sq. ft.** minimum as required by the IBC.
- F. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of ~~<Insert inches>~~.

~~2.2 FRAMING SYSTEMS~~

- ~~A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.~~
- ~~B. Framing Members, General: Comply with [ASTM C645] [AISI S220 and ASTM C645, Section 10] [AISI S220] for conditions indicated.~~
 - ~~1. Steel Sheet Components: Comply with [ASTM C645] [AISI S220 and ASTM C645, Section 10] [AISI S220] requirements for metal unless otherwise indicated~~
 - ~~2. Protective Coating: Comply with [ASTM C645] [AISI S220]; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.~~
 - ~~a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.~~

C. ~~Slip-Type Head Joints: Where indicated, provide [one of] the following:~~

1. ~~Single Long-Leg Track System: Top track with 2-inch 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 of the top of studs to provide lateral bracing.~~
2. ~~Double-Track System: Top outer tracks, inside track with 2-inch deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.~~

D. ~~Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges.~~

1. ~~Depth: [As indicated on Drawings] [3/4 inch] <Insert depth>.~~
2. ~~Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.~~
3. ~~Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.~~

2.32.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.
- B. Hanger Attachments to Concrete:
 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [AC01] [AC193] [AC58] [or] [AC308] as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: [Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor].
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1] [Group 2] stainless steel bolts, ASTM F593, and nuts, ASTM F594.
 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, [in size indicated on Drawings] [1 by 3/16 inch by length indicated] <Insert size>.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch wide flanges.
 1. Depth: [As indicated on Drawings] [2-1/2 inches] [2 inches] [1-1/2 inches].
- F. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges, 3/4 inch deep.
 2. Steel Studs and Tracks:

- a. Minimum Base-Steel Thickness: [As indicated on Drawings] [0.0179 inch] [0.0269 inch] [0.0296 inch] [0.0329 inch].
 - b. Depth: [As indicated on Drawings] [1-5/8 inches] [2-1/2 inches] [3-5/8 inches].
3. High-Strength Steel Studs and Tracks:
 - a. Minimum Base-Steel Thickness: [As indicated on Drawings] [0.0147 inch] [0.0180 inch] <Insert thickness>.
 - b. Depth: [As indicated on Drawings] [1-5/8 inches] [2-1/2 inches] [3-5/8 inches].
4. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.
 - a. Minimum Base-Steel Thickness: [As indicated on Drawings] [0.0179 inch] [0.0296 inch] [0.0329 inch] <Insert thickness>.
5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a. Configuration: [Asymmetrical] [or] [hat shaped].

2.42.3 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 thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches** o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 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.

3.4 ~~INSTALLATION OF FRAMING SYSTEMS~~

- ~~A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 1. Single-Layer Application: ~~[As required by horizontal deflection performance requirements]~~ ~~[16 inches o.c.] [24 inches o.c.]~~ unless otherwise indicated.
 2. Multilayer Application: ~~[As required by horizontal deflection performance requirements]~~ ~~[16 inches o.c.] [24 inches o.c.]~~ unless otherwise indicated.
 3. Tile Backing Panels: ~~[As required by horizontal deflection performance requirements]~~ ~~[16 inches o.c.]~~ unless otherwise indicated.~~
- ~~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** 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** 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** o.c.
- F. — Z-Shaped Furring Members:
1. — Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced [**24 inches**] ~~<Insert dimension>~~ o.c.
 2. — Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches** o.c.
 3. — At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches** from corner and cut insulation to fit.
- G. — Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch** from the plane formed by faces of adjacent framing.

3.5.4 INSTALLATION OF SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: [48 inches] <Insert dimension> o.c.
 - 2. Carrying Channels (Main Runners): [48 inches] <Insert dimension> o.c.
 - 3. Furring Channels (Furring Members): [16 inches] [24 inches] <Insert dimension> o.c.
- 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] <Insert deflection limit>.
 - 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] <Insert requirements>.

3.6 INSTALLATION OF GRID SUSPENSION SYSTEMS

- A. ~~Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.~~

3.73.5 FIELD QUALITY CONTROL

- A. Installation Tolerances: Install suspension systems that are level to within [**1/8 inch in 12 feet**] <Insert dimensions> measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092300 - GYPSUM PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Expanded-metal lath.~~
- ~~2. Base-coat gypsum plaster materials.~~
- ~~3. Finish-coat gypsum plaster materials.~~

~~B. Related Requirements:~~

- ~~1. Section 092613 "Gypsum Veneer Plastering" for gypsum-based veneer plaster applied on gypsum base for veneer plaster, unit masonry, and monolithic concrete.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Expanded-metal lath.
2. Base-coat gypsum plaster materials.
3. Finish-coat gypsum plaster materials.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.3 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for each substrate and finish texture indicated for gypsum plastering, including accessories.
 - a. Size: [100 sq. ft.] <Insert dimension> in surface area.
2. Simulate finished lighting conditions for review of mockups.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, contamination, corrosion, construction traffic, and other causes.

1.5 FIELD CONDITIONS

- A. Comply with ASTM C842 requirements or gypsum plaster manufacturer's written recommendations, whichever are more stringent.
- B. Room Temperatures: Maintain temperatures at not less than **55 deg F** or greater than **80 deg F** for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
- C. Avoid conditions that result in gypsum plaster drying out too quickly.
 1. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
 2. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
 3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plaster materials from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.
- B. Sound-Transmission Characteristics: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings in accordance with ASTM E90 and classified in accordance with ASTM E413 by a qualified testing agency.

~~2.3 ACCESSORIES~~

- ~~A. General: Comply with ASTM C841, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.~~

2.42.3 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Bonding Compound: ASTM C631.
- C. Fasteners for Attaching Metal Lath to Substrates: ASTM C841.
- D. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch** diameter unless otherwise indicated.
- E. 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 rated assembly.
 - 2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.
- F. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
- G. Mix Additives: Use gypsum plaster accelerators and retarders from plaster manufacturer if required by Project conditions. Use only additives that manufacturer recommends in writing for use with plaster to which it is added.

2.5 BASE-COAT GYPSUM PLASTER MATERIALS

- A. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.~~
- B. ~~Aggregates for Base-Coat Plasters: ASTM C35, **[sand]** **[and]** **[perlite]**.~~

2.6 FINISH-COAT GYPSUM PLASTER MATERIALS

- A. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.~~
- B. ~~Aggregates for Float Finishes: ASTM C35, **[sand]** **[perlite]**; graded in accordance with ASTM C842.~~

2.72.4 PLASTER MIXES

- A. Mixing: Comply with ASTM C842 and manufacturer's written instructions for applications indicated.
- B. Mix Additives: Use accelerators and retarders, if required by Project conditions, according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Reject plaster materials that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.3 INSTALLATION, GENERAL

- A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
- B. STC-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
- C. Sound-Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
- D. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

~~3.4 INSTALLATION OF EXPANDED-METAL LATH~~

- ~~A. Expanded-Metal Lath: Install in accordance with ASTM C841.~~

- ~~1. Partition Framing and Vertical Furring: Install ~~[flat-diamond-mesh]~~ ~~[flat-rib]~~ lath.~~
- ~~2. Flat-Ceiling and Horizontal Framing: Install ~~[flat-diamond-mesh]~~ ~~[flat-rib]~~ lath.~~
- ~~3. Curved-Ceiling Framing: Install flat-diamond-mesh lath.~~
- ~~4. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.~~
- ~~5. Solid-Plaster Partitions: Where supported by channel studs and L-runners, install ~~[flat-rib]~~ ~~[flat-diamond-mesh]~~ lath.~~
- ~~6. Studless Solid-Plaster Partitions: Where supported by L-runners, install ~~3/8-inch~~ rib lath.~~

~~3.5 INSTALLATION OF ACCESSORIES~~

- ~~A. General: Install in accordance with ASTM C841.~~
- ~~B. Cornerbeads: Install at external corners.~~

- C. ~~Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.~~
- D. ~~Control Joints: Locate as approved by Architect for visual effect, with spacing between joints in either direction not exceeding the following:~~
 - 1. ~~Partitions: 30 feet.~~
 - 2. ~~Ceilings: [50 feet] [30 feet].~~
- E. ~~Aluminum Trim: Install according to manufacturer's written instructions.~~

~~3.63.4~~ APPLICATION OF PLASTER

- A. General: Comply with ASTM C842.
 - 1. Do not deviate more than plus or minus **1/8 inch in 10 feet** from a true plane in finished plaster surfaces when measured by a **10-foot** straightedge placed on surface.
 - 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
 - 3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Bonding Compound: Apply on ~~[unit masonry]~~ ~~[and]~~ ~~[concrete]~~ substrates for direct application of plaster.

~~3.7~~ INSTALLATION OF BASE-COAT GYPSUM PLASTER MATERIALS

- A. ~~Over Expanded-Metal Lath:~~
 - 1. ~~Scratch Coat: [Gypsum neat plaster with job-mixed sand] [Gypsum wood-fibered plaster, neat or with job-mixed sand] [High-strength gypsum neat plaster with job-mixed sand] <Insert requirements>.~~
 - 2. ~~Brown Coat: [Lightweight gypsum ready-mixed plaster] [Gypsum neat plaster with job-mixed sand] [Gypsum neat plaster with job-mixed perlite] [Gypsum wood-fibered plaster with job-mixed sand] [High-strength gypsum neat plaster with job-mixed sand] <Insert requirements>.~~
- B. ~~Over Unit Masonry: [Lightweight gypsum ready-mixed plaster] [Wood-fibered gypsum plaster with job-mixed sand] [Gypsum neat plaster with job-mixed sand] <Insert requirements>.~~
- C. ~~Over Monolithic Concrete: [Gypsum neat plaster with job-mixed sand] <Insert requirements>.~~

~~3.8~~ INSTALLATION OF FINISH-COAT GYPSUM PLASTER MATERIALS

- A. ~~Smooth-Troweled Finishes:~~
 - 1. ~~Materials: [Gypsum gaging plaster and lime putty] [Gypsum ready-mixed finish plaster] [High-strength gypsum gaging plaster and lime putty] [Gypsum Keene's cement and lime putty] <Insert requirements>.~~
 - 2. ~~Locations: Provide smooth-troweled finish [unless otherwise indicated] [where indicated] <Insert locations>.~~

B. ~~Float Finishes:~~

1. ~~Materials: [Gypsum gaging plaster and lime putty] [Gypsum Keene's cement and lime putty] <Insert requirements>.~~
2. ~~Locations: Provide float finish [unless otherwise indicated] [where indicated] <Insert locations>.~~

C. ~~Sprayed Finishes: [Match Architect's sample] <Insert requirements>.~~

1. ~~Materials: [Gypsum ready-mixed finish plaster] <Insert requirements>.~~
2. ~~Locations: Provide sprayed finish [unless otherwise indicated] [where indicated] <Insert locations>.~~

D. ~~Textured Finishes: [Match Architect's sample] <Insert requirements>.~~

1. ~~Materials: [Gypsum ready-mixed finish plaster] <Insert requirements>.~~
2. ~~Locations: Provide textured finish [unless otherwise indicated] [where indicated] <Insert locations>.~~

E. ~~Concealed Plaster:~~

1. ~~Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.~~
2. ~~Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.~~
3. ~~Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.~~

3.93.5 REPAIR

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.103.6 CLEANING

- A. Remove temporary protection and enclosure of other work after plastering is complete.
- B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.
- C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092300

SECTION 092400 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Metal lath.~~
- ~~2.1. Base-coat cement plaster.~~
- ~~3. Cement plaster finish coats.~~
- ~~4. Accessories.~~

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Metal lath.
2. Base-coat cement plaster.
3. Cement plaster finish coats.
4. Accessories.

- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

- C. Samples: For each type of factory-prepared finish coat and for each color and texture specified.

- D. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and texture specified.

- E. Samples for Verification: For each type of factory-prepared finish coat and for each color and texture specified, **12 by 12 inches**, and prepared on rigid backing.

F. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.

1.4 MOCKUPS

- A. 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 for each substrate and finish texture indicated for cement plastering, including accessories.
 - a. Size: [100 sq. ft.] <Insert dimension> in surface area.
 - 2. For interior plasterwork, simulate finished lighting conditions for review of mockups.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

- A. Comply with ASTM C926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F.
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F for at least 48 hours before plaster application, and continuously during and after application.
 - 1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
 - 2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.
- D. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plaster materials from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide cement plaster assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by a qualified testing agency.

~~2.3 METAL LATH~~

- ~~A. Paper Backing: FS UU-B-790a, Type I, [Grade D, Style 2 vapor-permeable paper] [Grade B, Style 1a vapor-retardant paper] <Insert requirements>.~~

- ~~1. Provide paper-backed lath [unless otherwise indicated] [at exterior locations] [in locations indicated on Drawings] <Insert locations>.~~

2.4.2.3 BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926 for applications indicated.
1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed **1 lb of fiber/cu. yd.** of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
1. Portland Cement Mixes:
- a. Scratch Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
- b. Brown Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
2. Masonry Cement Mixes:
- a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
- b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
3. Portland and Masonry Cement Mixes:
- a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
- b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
4. Plastic Cement Mixes:
- a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
- b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

5. Portland and Plastic Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Base-Coat Mixes for Use over Low-Absorption Unit Masonry and Concrete: Single base (scratch) coat for two-coat plasterwork on low-absorption plaster bases as follows:
 1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 2. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 3. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.
- D. Base-Coat Mixes for Use over High-Absorption Unit Masonry and Concrete: Single base (scratch) coat for two-coat plasterwork on high-absorption plaster bases as follows:
 1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 2. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
 3. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 4. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

2.5 CEMENT PLASTER FINISH COATS

A. Job-Mixed Finish-Coat Mixes:

1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and [3/4 to 1-1/2] [1-1/2 to 2] parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
2. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.
3. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
4. Plastic Cement Mix: Use 1 part plastic cement and 1-1/2 to 3 parts aggregate.

2.6 ACCESSORIES

- A. General: Comply with ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

2.7.4 PLASTER MATERIALS

- A. Portland Cement: ASTM C150/C150M, [Type I] [Type II].
 1. Color for Finish Coats: [White] [Gray].

- B. Masonry Cement: ASTM C91/C91M, Type N.
 - 1. Color for Finish Coats: **[White]** **[Gray]**.
- C. Plastic Cement: ASTM C1328/C1328M.
- D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color **[to match Architect's sample]** **<Insert requirements>**.
- E. Lime: ASTM C206, Type S; or ASTM C207, Type S.
- F. Sand Aggregate: ASTM C897.
 - 1. Color for Job-Mixed Finish Coats: **[White]** **[In color matching Architect's sample]**.
- G. Perlite Aggregate: ASTM C35.
- H. Exposed Aggregates for Finish Coats: **[For marblecrete finish, clean, sound, crushed marble matching color and size gradation of Architect's sample]** **<Insert requirements>**.

2.82.5 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, **1/2 inch** long, free of contaminants, manufactured for use in cement plaster.
- C. Bonding Compound: ASTM C932.
- D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.
- E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than **0.0475-inch** diameter unless otherwise indicated.
- F. 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 **<Insert value>** percent.
- G. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster in accordance with ASTM C926.

3.3 INSTALLATION, GENERAL

- A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
- B. Sound-Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

3.4 ~~INSTALLATION OF METAL LATH~~

- A. ~~Metal Lath: Install in accordance with ASTM C1063.~~

- 1. ~~Partition Framing and Vertical Furring: Install [flat diamond mesh] [flat rib] [welded wire] [woven wire] lath.~~
- 2. ~~Flat Ceiling and Horizontal Framing: Install [flat diamond mesh] [flat rib] [3/8-inch rib] [welded wire] [woven wire] lath.~~
- 3. ~~Curved Ceiling Framing: Install [flat diamond mesh] [welded wire] [flat woven wire] lath.~~
- 4. ~~On Solid Surfaces, Not Otherwise Furred: Install self-furring, [diamond mesh] [welded wire] [woven wire] lath.~~

3.5 ~~INSTALLATION OF ACCESSORIES~~

- A. ~~Install in accordance with ASTM C1063 and at locations indicated on Drawings.~~
- B. ~~Reinforcement for External (Outside) Corners:~~
 - 1. ~~Install [lath type, external corner reinforcement] [corner bead] at exterior locations.~~
 - 2. ~~Install corner bead at interior locations.~~
- C. ~~Control Joints: Locate as approved by Architect for visual effect and as follows:~~
 - 1. ~~As required to delineate plasterwork into areas (panels) of the following maximum sizes:~~

a. ~~Vertical Surfaces: 144 sq. ft.~~

b. ~~Horizontal and Other Nonvertical Surfaces: 100 sq. ft.~~

2. ~~At distances between control joints of not greater than 18 feet o.c.~~

3. ~~As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.~~

4. ~~Where control joints occur in surface of construction directly behind plaster.~~

5. ~~Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.~~

3.63.4 APPLICATION OF BASE-COAT CEMENT PLASTER

A. General: Comply with ASTM C926.

1. Do not deviate more than plus or minus **1/4 inch in 10 feet** from a true plane in finished plaster surfaces when measured by a **10-foot** straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Bonding Compound: Apply on **[unit masonry]** **[and]** **[concrete]** substrates for direct application of plaster.

C. Walls; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork with **3/4-inch** total thickness, as follows:

1. Portland cement mixes.
2. Masonry cement mixes.
3. Portland and masonry cement mixes.
4. Plastic cement mixes.
5. Portland and plastic cement mixes.

D. Ceilings; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork and having **[1/2-inch total thickness]** **[3/4-inch total thickness for metal lath on concrete]**, as follows:

1. Portland cement mixes.
2. Masonry cement mixes.
3. Portland and masonry cement mixes.
4. Plastic cement mixes.
5. Portland and plastic cement mixes.

E. Walls; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having **[3/8-inch thickness on masonry]** **[1/4-inch thickness on concrete]**, as follows:

1. Portland cement mix.
2. Masonry cement mix.
3. Portland and masonry cement mix.
4. Plastic cement mix.
5. Portland and plastic cement mix.

- F. Ceilings; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having **1/4-inch** thickness on concrete, as follows:
1. Portland cement mix.
 2. Masonry cement mix.
 3. Portland and masonry cement mix.
 4. Plastic cement mix.
 5. Portland and plastic cement mix.

~~3.7 APPLICATION OF CEMENT PLASTER FINISH COATS~~

- A. ~~Plaster Finish Coats: Apply to provide [float] [dash] [scraped trowel-textured] [skip trowel-textured] [brocade (knock-down dash)] [trowel-sweep] [combed] [sacked (California mission)] [English] [marblecrete] <Insert requirements> finish to match Architect's sample.~~
- B. ~~Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.~~
- C. ~~Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.~~
- D. ~~Concealed Interior Plasterwork:~~
1. ~~Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.~~
 2. ~~Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.~~
 3. ~~Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.~~

3.83.5 REPAIR

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.93.6 CLEANING

- A. Remove temporary protection and enclosure of other work after plastering is complete.
- B. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.
- C. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

SECTION 092900 - 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.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
5. Section 092613 "Gypsum Veneer Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.
6. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Flexible gypsum board.
4. Gypsum ceiling board.
5. Foil-backed gypsum board.
6. Abuse-resistant gypsum board.
7. Impact-resistant gypsum board.
8. Mold-resistant gypsum board.
9. Gypsum board, Type C.
10. Glass-mat interior gypsum board.
11. Acoustically enhanced gypsum board.
12. Skim-coated gypsum board.
13. Exterior gypsum soffit board.
14. Glass-mat gypsum sheathing board.
15. Glass-mat, water-resistant backing board.
16. Cementitious backer units.

- ~~17. Water-resistant gypsum backing board.~~
- ~~18. Interior trim.~~
- ~~19. Exterior trim.~~
- ~~20. Aluminum trim.~~
- ~~21. Joint treatment materials.~~
- ~~22. Laminating adhesive.~~
- ~~23. Sound-attenuation blankets.~~
- ~~24. Acoustical sealant.~~
- ~~25. Textured finishes.~~

- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in **12-inch** long length for each trim accessory indicated.
 - 2. Textured Finishes: **[Manufacturer's standard size]** <Insert size> for each textured finish indicated and on same backing indicated for Work.
- D. Samples for Initial Selection: For each type of **[trim accessory]** **[and]** **[textured finish]** indicated.
- E. Samples for Verification: For the following products:
 - 1. Trim Accessories: Full-size Sample in **12-inch** long length for each trim accessory indicated.
 - 2. Textured Finishes: **[Manufacturer's standard size]** <Insert size> for each textured finish indicated and on same backing indicated for Work.
- F. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.
 - 3. Health Product Declaration (HPD): Provide documentation indicating that manufacturer has screened and publicly provided ingredient disclosure to 1000 ppm, and has developed an action plan to mitigate known hazards.
 - 4. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 - 5. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
 - 6. Product Data: For adhesives and sealants, indicating VOC content.
 - 7. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
 - 8. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.
 - 9. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.
 - 10. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.
 - 11. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.3 MOCKUPS

- A. Build mockups of at least **100 sq. ft.** in surface area to demonstrate aesthetic effects and to set quality standards for materials and

execution.

1. Build mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each texture finish indicated.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

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

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with 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 in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

- C. Ceiling and wall materials shall 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."
- D. Ceiling and wall materials shall 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."
- E. Ceiling and wall materials shall 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."
Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.
- F. Ceiling and wall materials shall 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."

2.3 GYPSUM BOARD, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than ~~<Insert value>~~ percent.
- B. Regional Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- C. Regional Materials: Products shall be manufactured within **500 miles** of Project site.
- D. Regional Materials: Products shall be manufactured within **100 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- E. Indigenous Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Regional Materials: Products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- G. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 ~~TRIM ACCESSORIES~~

A. ~~Interior Trim: ASTM C1047.~~

- 1. ~~Material: [Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet] [Galvanized or aluminum-coated steel sheet or rolled zinc] [Plastic] [Paper-faced galvanized steel sheet].~~
- 2. ~~Shapes:~~
 - a. ~~Corner bead.~~
 - b. ~~Bullnose bead.~~
 - c. ~~LC Bead: J-shaped; exposed long flange receives joint compound.~~
 - d. ~~L Bead: L-shaped; exposed long flange receives joint compound.~~

- e. ~~U-Bead: J-shaped; exposed short flange does not receive joint compound.~~
- f. ~~Expansion (control) joint.~~
- g. ~~Curved-Edge Cornerbead: With notched or flexible flanges.~~

B. ~~Exterior Trim: ASTM C1047.~~

- 1. ~~Material: [Hot-dip galvanized steel sheet, plastic, or rolled zinc] <Insert material>.~~
- 2. ~~Shapes:~~
 - a. ~~Cornerbead.~~
 - b. ~~LC-Bead: J-shaped; exposed long flange receives joint compound.~~
 - c. ~~Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.~~

2.52.4 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[, **rounded or beveled panel edges,**] and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use **[setting-type taping] [drying-type, all-purpose]** compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
 - 4. Finish Coat: For third coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use **[setting-type, sandable topping compound] [drying-type, all-purpose compound] [high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish].**
- D. Joint Compound for Exterior Applications:
 - 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
 - 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
- E. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 - 2. Cementitious Backer Units: As recommended by backer unit manufacturer.
 - 3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

4. <Insert products>.

2.62.5 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. Adhesives shall have a VOC content of [50] <Insert value> g/L or less.
 - 2. Adhesive 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."
 - 3. Adhesive 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."
 - 4. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - 5. Adhesive 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."
 - 6. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- 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 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 <Insert value> percent.
- E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
 - 1. Sealant shall have a VOC content of 250 g/L or less.
 - 2. Sealant 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."
 - 3. Sealant 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."
 - 4. Sealant 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Sealant 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."
 6. Sealant 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- G. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

2.7 — TEXTURE FINISHES

- A. — Primer: As recommended by textured finish manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch** of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft.** in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch** wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide **1/4- to 1/2-inch** wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 — ~~INSTALLATION OF INTERIOR GYPSUM BOARD~~

A. — ~~Install interior gypsum board in the following locations:~~

1. — ~~Wallboard Type: [As indicated on Drawings] [Vertical surfaces unless otherwise indicated].~~
2. — ~~Type X: [As indicated on Drawings] [Where required for fire-resistance-rated assembly] [Vertical surfaces unless otherwise indicated] <Insert requirements>.~~
3. — ~~Flexible Type: [As indicated on Drawings] [Apply in double layer at curved assemblies].~~
4. — ~~Ceiling Type: [As indicated on Drawings] [Ceiling surfaces].~~
5. — ~~Foil-Backed Type: [As indicated on Drawings] <Insert requirements>.~~
6. — ~~Abuse-Resistant Type: [As indicated on Drawings] <Insert requirements>.~~
7. — ~~Impact-Resistant Type: [As indicated on Drawings] <Insert requirements>.~~
8. — ~~Mold-Resistant Type: [As indicated on Drawings] <Insert requirements>.~~
9. — ~~Type C: [As indicated on Drawings] [Where required for specific fire-resistance-rated assembly indicated].~~
10. — ~~Glass-Mat Interior Type: [As indicated on Drawings] <Insert requirements>.~~
11. — ~~Acoustically Enhanced Type: [As indicated on Drawings] <Insert requirements>.~~
12. — ~~Skim-Coated Type: [As indicated on Drawings] <Insert requirements>.~~

B. — ~~Single-Layer Application:~~

1. — ~~On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.~~
2. — ~~On partitions/walls, apply gypsum panels [vertically (parallel to framing)] [horizontally (perpendicular to framing)] unless~~

otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

- a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
- b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, **16 inches** minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers ~~[and face layers separately to supports with screws]~~ ~~[with screws; fasten face layers with adhesive and supplementary fasteners].~~

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus **12-inch** long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws **16 inches** o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced **12 inches** o.c.

3.43.3 INSTALLATION OF EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
1. Install with **1/4-inch** open space where panels abut other construction or structural penetrations.
 2. Fasten with corrosion-resistant screws.

3.5 INSTALLATION OF TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at ~~[showers, tubs, and where indicated on Drawings]~~ ~~[locations indicated to receive tile]~~. Install with **1/4-inch** gap where panels abut other construction or penetrations.

- B. ~~Cementitious Backer Units: ANSI A108.11, at [showers, tubs, and where indicated on Drawings] [locations indicated to receive tile].~~
- C. ~~Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.~~
- D. ~~Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.~~

3.6 ~~INSTALLATION OF TRIM ACCESSORIES~~

- A. ~~General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.~~
- B. ~~Control Joints: Install control joints [at locations indicated on Drawings] [in accordance with ASTM C840 and in specific locations approved by Architect for visual effect].~~
- C. ~~Interior Trim: Install in the following locations:~~
 - 1. ~~Cornerbead: Use at outside corners [unless otherwise indicated].~~
 - 2. ~~Bullnose Bead: Use [at outside corners] [where indicated on Drawings] <Insert requirements>.~~
 - 3. ~~LC-Bead: Use [at exposed panel edges] <Insert requirements>.~~
 - 4. ~~L-Bead: Use [where indicated on Drawings] <Insert requirements>.~~
 - 5. ~~U-Bead: Use [at exposed panel edges] [where indicated on Drawings] <Insert requirements>.~~
 - 6. ~~Curved-Edge Cornerbead: Use at curved openings.~~
- D. ~~Exterior Trim: Install in the following locations:~~
 - 1. ~~Cornerbead: Use at outside corners.~~
 - 2. ~~LC-Bead: Use [at exposed panel edges] <Insert requirements>.~~
- E. ~~Aluminum Trim: Install in locations [indicated on Drawings] <Insert requirements>.~~

3.7.3.4 FINISHING OF GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints[, rounded or beveled edges,] and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: [Panels that are substrate for tile] [Panels that are substrate for acoustical tile] [Where indicated on Drawings] <Insert locations>.
 - 3. Level 3: [Where indicated on Drawings] <Insert locations>.
 - 4. Level 4: [At panel surfaces that will be exposed to view unless otherwise indicated] <Insert locations>.

- a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- 5. Level 5: **[Where indicated on Drawings]** <Insert locations>.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

~~3.8~~ APPLICATION OF 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.~~
- ~~C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture finish manufacturer's written instructions.~~

~~3.93.5~~ PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ~~Quarry tile.~~
2. ~~Pressed floor tile.~~
3. ~~Porcelain tile.~~
4. ~~Ceramic mosaic tile.~~
5. ~~Glazed wall tile.~~
6. 1. ~~Thresholds.~~
7. ~~Tile backing panels.~~
8. ~~Waterproof membranes.~~
9. ~~Crack isolation membranes.~~
10. 2. ~~Setting material.~~
11. ~~Grout materials.~~

B. ~~Related Requirements:~~

1. ~~[Section 071326 "Self-Adhering Sheet Waterproofing"] [Section 071353 "Elastomeric Sheet Waterproofing"] [Section 071354 "Thermoplastic Sheet Waterproofing"] [Section 071413 "Hot Fluid-Applied Rubberized Asphalt Waterproofing"] [Section 071416 "Cold Fluid-Applied Waterproofing"] for waterproofing under thickset mortar beds.~~
2. ~~Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.~~
3. ~~Section 092400 "Cement Plastering" for scratch coat for thickset mortar setting-bed installations.~~
4. ~~Section 092613 "Gypsum Veneer Plastering" for cementitious backer units.~~
5. ~~Section 092900 "Gypsum Board" for tile backing panels.~~
6. ~~Section 093023 "Glass Tiling."~~
7. ~~Section 093033 "Stone Tiling."~~
8. ~~Section 096340 "Stone Flooring" for stone thresholds.~~

1.2 DEFINITIONS

- A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Large Format Tile: Tile with at least one edge **15 inches** or longer.
- D. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Quarry tile.
 - 2. Pressed floor tile.
 - 3. Porcelain tile.
 - 4. Ceramic mosaic tile.
 - 5. Glazed wall tile.
 - 6. Thresholds.
 - 7. Tile backing panels.
 - 8. Waterproof membranes.
 - 9. Crack isolation membranes.
 - 10. Setting material.
 - 11. Grout materials.
- B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces. **[Show thresholds.]**
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection or shade variation.
- D. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required. **[For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.] [For tile with aesthetic classification V3 or V4, provide 12 tiles from same production run.]**
 - 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. Make samples at least **[12 inches square] [36 inches square]** **<Insert size>**, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory **[for each color and finish required]**.
 - 4. Stone thresholds in **6-inch** lengths.
 - 5. Metal flooring transitions **6-inch** lengths.
- E. Sustainable Design Submittals:
 - 1. Environmental Product Declaration: For each product.
 - 2. Health Product Declaration: For each product.
 - 3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - 4. Environmental Product Declaration: For each product.
 - 5. Environmental Product Declaration: For each product.
 - 6. Environmental Product Declaration: For each product.
 - 7. Third-Party Certifications: For each product.

8. Third-Party Certified Life Cycle Assessment: For each product.
9. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
10. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
11. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
12. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
13. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, including product use classification.
- D. Product Test Reports:
 1. Tile-setting and -grouting products.
 2. Certified porcelain tile.
 3. Slip-resistance test reports from qualified independent testing agency.
- E. Field Quality-Control Reports: Water test reports of membrane in wet areas.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the 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 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.]
 - a. <Insert, in separate subparagraphs, tile-type designation or description and quantity required for each category of tile for which extra material is required>.
 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer is [a Five-Star member of the National Tile Contractors Association] [or] [a Trowel of Excellence member of the Tile Contractors' Association of America].
 2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
 3. Installer employs only [Ceramic Tile Education Foundation Certified Installers] [or] [installers recognized by the U.S. Department of Labor as Journeyman Tile Layers] for Project.
 4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of [mud floors] [mud walls] [membranes] [shower receptors] [and] [large format tile].

1.8 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of [**each type of**] floor tile installation.
 - 2. Build mockup of [**each type of**] wall tile installation.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in "Referenced Standards" Article in the Evaluations and manufacturer's written instructions.

1.11 WARRANTY

- A. System Warranty: Manufacturer's non-prorated comprehensive warranty that agrees to repair and replace defective installation areas, material, and labor that fail under normal usage within specified warranty period.
 - 1. Warranty Period: [**Five years**] [**10 years**] [**25 years**] [**Lifetime**] from date of Product Purchase.

PART 2 - PRODUCTS

~~2.1 SOURCE LIMITATIONS~~

- ~~A. Tile: Obtain [**tile of each type and color or finish**] [**tile of each type**] [**tile of each color or finish**] [**tile**] from single source or producer.
 - ~~1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.~~~~
- ~~B. Accessory Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - ~~1. Stone thresholds.~~~~

~~2. Backer units.~~

~~2.2.1~~ PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard Grade requirements [**unless otherwise 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.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation [**in swimming pools**] [**on exteriors**] [**or**] [**in wet areas**], do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

~~2.3 GLAZED WALL TILE~~

- A. ~~Accessories: Provide vitreous china accessories of type and size indicated; suitable for installing by same method as used for adjoining wall tile.~~
 - ~~1. One soap holder [**with grab handle**] for each shower and tub indicated.~~
 - ~~2. One paper holder at each water closet.~~
 - ~~3. Color and Finish: [**Match adjoining glazed wall tile**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] [**White, bright glaze**] <Insert color and finish>.~~

~~2.4.2~~ THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to **1/16 inch** above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to **1/2 inch** or less above adjacent floor surface.
- B. Granite Thresholds: ASTM C615/C615M, with [**polished**] [**honed**] <Insert finish> finish.
 - 1. Description:
 - a. Uniform, [**fine**] [**medium**]-grained, [**white**] [**gray**] [**black**] <Insert color> stone without veining.

- b. Match Architect's sample.
 - c. Provide[**one of**] the following:
 - 1) <Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>.
- C. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of [10] [12] in accordance with ASTM C1353/C1353M or ASTM C241/C241M and with honed finish.
 - 1. Description:
 - a. Uniform, fine- to medium-grained white stone with gray veining.
 - b. Match Architect's sample.
 - c. Provide[**one of**] the following:
 - 1) <Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>.
- D. Slate Thresholds: ASTM C629/C629M, Classification [I Exterior] [II Interior], with fine, even grain and honed finish.
 - 1. Description:
 - a. Uniform, [black] [blue-black] [gray] [blue-gray] [green] <Insert color> stone[and unfading].
 - b. Match Architect's sample.
 - c. Provide[**one of**] the following:
 - 1) <Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>.
- E. Solid Surface: Homogeneous-filled plastic resin complying with ISFA-02-01.
 - 1. Description:
 - a. Type: Provide [Standard] [Special Purpose] type.
 - b. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

2.5 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product[, **selected from the following,**] that complies with ANSI A118.10 [and ANSI A118.12] and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

2.6 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product[, **selected from the following,**] that complies with ANSI A118.12 for [standard performance] [high performance] and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

2.7 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Installer's option of material that complies with ANSI A108.02, paragraph 3.8.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, **2 by 2 inches** by **0.062-inch** diameter; comply with ASTM A1064/A1064M except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C847.
 - a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
 - b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
 - c. Configuration over Studs and Furring: Flat.
 - d. Configuration over Solid Surfaces: Self-furring.
 - e. Weight: **[2.5 lb/sq. yd.] [3.4 lb/sq. yd.]**.
4. Latex Additive: **[Manufacturer's standard] [acrylic resin] [or] [styrene-butadiene-rubber]** 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.

2.8 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Grout for PregROUTed Tile Sheets: Same product used in factory to pregROUT tile sheets.

2.9 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayment and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile setting and adhesive materials for installations indicated.
- B. Vapor Retarder Membrane: Polyethylene sheeting, ASTM D4397, **4.0 mils** thick.
- C. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces; specifically approved for materials and installations indicated by tile and grout manufacturers.
- E. Grout Sealer: Grout manufacturer's standard product for sealing grout joints 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.
 - 2. Verify that concrete substrates for tile floors installed with [adhesives] [bonded mortar bed] [or] [thinset mortar] comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with [adhesives] [or] [thinset mortar] with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped **1/4 inch per foot** toward drains.
- D. 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.
- E. Substrate Flatness:
 - 1. For tile shorter than **15 inches**, confirm that structure or substrate is limited to variation of **1/4 inch in 10 ft.** from the required plane, and no more than **1/16 inch in 12 inches** when measured from tile surface high points.
 - 2. For large format tile, tile with at least one edge **15 inches** or longer, confirm that structure or substrate is limited to **1/8 inch in 10 ft.** from the required plane, and no more than **1/16 inch in 24 inches** when measured from tile surface high points.
- F. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.
- B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- D. Mix mortars and grouts to comply with "Referenced Standards" Article in the Evaluations and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.
- E. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Exterior tile floors and walls.
 - b. Tile floors in wet areas.
 - c. Tile swimming pool decks.
 - d. Tile floors in laundries.
 - e. Tile floors consisting of tiles **8 by 8 inches** or larger.
 - f. Tile floors consisting of rib-backed tiles.
 - 2. 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.
 - 3. 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.
 - 4. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
 - 5. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
 - 6. 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 use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets, so joints between

- sheets are not apparent in finished Work.
 - b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
7. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- F. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- G. Thresholds: Install stone and solid surface thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in **[modified dry-set] [improved modified dry-set]** mortar (thinset).
2. Do not extend **[cleavage membrane] [waterproof membrane] [or] [crack isolation membrane]** under thresholds set in **[standard dry-set] [modified dry-set] [or] [improved modified dry-set]** mortar. Fill joints between such thresholds and adjoining tile set on **[cleavage membrane] [waterproof membrane] [or] [crack isolation membrane]** with elastomeric sealant.
- H. Metal Flooring Transitions: Install **[at locations indicated] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated]**.
- I. Metal Wall Trim: Install at locations indicated on Drawings.
- J. Grout Sealer: Apply grout sealer to **[cementitious]** grout joints **[in tile floors]** in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- 3.4 FIELD QUALITY CONTROL
- A. Water Test:
1. Test of waterproofing membrane in showers and similar areas to be performed by Installation Contractor before setting tile.
- a. Perform test after 24 hours of waterproof membrane installation.
 - b. Insert test plug in drain or waste line.
 - c. Fill shower base with water, high enough that the membrane-to-drain connection and floor-to-wall transition can be evaluated, and mark wall.
 - d. Check for leaks after 24 hours.
2. Test to be witnessed by **[Architect] [authorities having jurisdiction] <Insert names or titles of witnesses>**.
- B. Nonconforming Work:
1. Waterproof membrane will be considered defective if water level has dropped.
2. Remove and replace defective components and retest.

3.5 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 EXTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Exterior Floor Installations:
 - 1. TCNA F101 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) [bonded to concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid applied] [Fabric reinforced, fluid applied].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
 - 2. TCNA F102 <Insert designation>: Thinset mortar [on concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated] [over crack isolation membrane on concrete] [over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.

- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- f. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- g. Movement Joints: Types located on Drawings.

B. Exterior Roof/Deck Floor Installations:

1. TCNA F103 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated] over drainage material on roof membrane.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA F104 <Insert designation>: Thinset mortar [on concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated] [over crack isolation membrane on concrete] [over crack isolation membrane on concrete where indicated and on concrete where membrane is not indicated].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - f. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - g. Movement Joints: Types located on Drawings.

C. Exterior Wall Installations, Masonry or Concrete:

1. TCNA W201 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) installed on metal lath [over waterproof membrane] [over water-resistant barrier] [over vapor-retarder membrane].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied

membrane] [Fabric-reinforced, fluid-applied membrane].

- e. Water-Resistive Barrier: Compliant with local code requirements [and] [specified in Division 07].
- f. Vapor Retarder: Compliant with local code requirements [and] [specified in Division 07].
- g. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- h. Movement Joints: Types located on Drawings.

- 2. TCNA W202E <Insert designation>: Thinset mortar [over waterproof membrane] [over water-resistive barrier] [over vapor retarder membrane].

- a. Ceramic Tile Type: <Insert tile-type designation>.
- b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
- c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Water-Resistive Barrier: Compliant with local code requirements [and] [specified in Division 07].
- f. Vapor Retarder: Compliant with local code requirements [and] [specified in Division 07].
- g. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- h. Movement Joints: Types located on Drawings.

D. Exterior Wall Installations, Wood or Metal Studs:

- 1. TCNA W244E <Insert designation>: Thinset mortar [over waterproof membrane on cementitious backer units] [on cementitious backer units over vapor-retarder membrane] [on cementitious backer units over water-resistive barrier].

- a. Ceramic Tile Type: <Insert tile-type designation>.
- b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
- c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Water-Resistive Barrier: Compliant with local code requirements [and] [specified in Division 07].
- f. Vapor Retarder: Compliant with local code requirements [and] [specified in Division 07].
- g. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- h. Movement Joints: Types located on Drawings.

3.8 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

- 1. TCNA F111 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) installed over cleavage membrane.

- a. Ceramic Tile Type: <Insert tile-type designation>.
- b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
- c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] grout.
- d. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.

- e. Movement Joints: Types located on Drawings.
2. TCNA F125-Full <Insert designation>: Thinset mortar on crack isolation membrane.
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
- B. Interior Floor Installations, Wood Subfloor:
1. TCNA F141 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) installed over cleavage membrane [over waterproof membrane].
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA F142 <Insert designation>: Organic adhesive on plywood underlayment.
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy] grout.
 - c. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - d. Movement Joints: Types located on Drawings.
- C. Interior Radiant Heat Floor Installations, Concrete Subfloor:
1. TCNA RH110 <Insert designation>: Thinset mortar [on crack isolation membrane]; hydronic piping installed in concrete.
- a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA RH115 <Insert designation>: Thinset mortar; electric radiant system encapsulated in thinset mortar.

- a. Ceramic Tile Type: <Insert tile-type designation>.
- b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.
- c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
- d. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- e. Movement Joints: Types located on Drawings.

D. Interior Radiant Heat Floor Installations, Wood Subfloor:

1. TCNA RH130 <Insert designation>: Thinset mortar on exterior-glue plywood; electric radiant system encapsulated in thinset mortar.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [EGP (exterior glue plywood) latex-portland cement] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - e. Movement Joints: Types located on Drawings.
2. TCNA RH141 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) installed over cleavage membrane [and waterproof membrane] with hydronic piping installed in mortar bed.
 - a. Ceramic Tile Type: <Insert stone tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.

E. Interior Wall Installations, Masonry or Concrete:

1. TCNA W2021 <Insert designation>: Thinset mortar [over waterproof membrane].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] [Water-cleanable epoxy] mortar.
 - c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA W211 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) bonded to substrate [over waterproof membrane].
 - a. Ceramic Tile Type: <Insert tile-type designation>.

- b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
- c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- f. Movement Joints: Types located on Drawings.

F. Interior Wall Installations, Wood or Metal Studs or Furring:

- 1. TCNA W242 <Insert designation>: Organic adhesive on gypsum board.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - c. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - d. Movement Joints: Types located on Drawings.
- 2. TCNA W245 <Insert designation>: Thinset mortar on glass-mat, water-resistant gypsum backer board[over waterproof membrane].
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.

G. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs or Furring:

- 1. TCNA B413 <Insert designation>: [Thinset mortar] [Organic adhesive] on [water-resistant gypsum] [coated glass-mat, water-resistant gypsum] backer board.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
 - d. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - e. Movement Joints: Types located on Drawings.

H. Bathtub/Shower Wall Installations:

- 1. TCNA B419 <Insert designation>: Thinset mortar[over waterproof membrane] on coated glass-mat, water-resistant gypsum backer board.
 - a. Ceramic Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Modified dry-set] [Improved modified dry-set] mortar.

- c. Grout: [Standard sanded cement] [Standard unsanded cement] [High-performance sanded cement] [High-performance unsanded cement] [Water-cleanable epoxy] grout.
- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- f. Movement Joints: Types located on Drawings.

3.9 CHEMICAL-RESISTANT TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete:

1. TCNA F115 <Insert designation>: Thinset mortar [over crack isolation membrane].
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Thinset Mortar: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: [Water-cleanable epoxy] [Chemical-resistant furan].
 - d. Crack Isolation Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Asphaltic sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.
2. TCNA F131 <Insert designation>: Water-cleanable, tile-setting epoxy.
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Grout: Water-cleanable epoxy.
 - c. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - d. Movement Joints: Types located on Drawings.

B. Interior Wall Installations, Masonry or Concrete:

1. TCNA W211 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. Cement mortar bed (thickset) bonded to substrate [over waterproof membrane].
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Latex-] portland cement mortar.
 - c. Grout: Water-cleanable epoxy.
 - d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
 - e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
 - f. Movement Joints: Types located on Drawings.

C. Interior Wall Installations, Solid Backing:

1. TCNA W222 <Insert designation>: Method [ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]. One-coat cement mortar bed (thickset) installed [over cleavage membrane] [over waterproof membrane] on solid backing.
 - a. Chemical-Resistant Tile Type: <Insert tile-type designation>.
 - b. Bond Coat for Cured-Bed Method: [Dry-set] [Modified dry-set] [Improved modified dry-set] mortar.
 - c. Grout: Water-cleanable epoxy.

- d. Waterproof Membrane: [As recommended by setting material manufacturer] [Polyethylene sheet] [Fluid-applied membrane] [Fabric-reinforced, fluid-applied membrane].
- e. Joint Width: [1/8 inch] [3/16 inch] [1/4 inch] [3/8 inch] <Insert width>.
- f. Movement Joints: Types located on Drawings.

END OF SECTION 093013

SECTION 095423 - LINEAR METAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Linear metal ceilings.

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.**

1.3 UNIT PRICES

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.**

1.4 ALTERNATES

- A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.**

1.5 COORDINATION

- A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.**

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.**

1. <Insert participant requirements>.

1.7 ACTION SUBMITTALS

- A. Product Data: For linear metal ceilings.**

- B. Sustainable Design Submittals:**

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

3. Product Data: For adhesives, indicating VOC content.
 4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - C. Shop Drawings: For linear metal ceilings.
 1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:
 - a. Linear ceiling patterns and joints.
 - b. Ceiling suspension members.
 - c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 - e. Ceiling perimeter and penetrations through ceiling; trim and moldings.
 - D. Samples: For each exposed product and for each type, color, and finish specified, **12 inches** long in size.
 - E. Samples for Initial Selection: For units with factory-applied colors and finishes.
 1. Include Samples of accessories involving color and finish selections.
 - F. Samples for Verification: For the following products:
 1. Linear Metal Pans: **12 inches** long by full-width Samples of each type, color, and finish and a **12-inch** long spliced section.
 2. Suspension-System Members: **12-inch** long Sample of each type.
 3. Exposed Molding and Trim: **12-inch** long Samples of each type, color, and finish.
 4. Filler Strips: **12-inch** long Samples of each type, color, and finish.
 5. Sound Absorbers: **12 inches** long by full width.
 6. End Caps: Full size.
 - G. Delegated Design Submittals: For design of [**seismic restraints and**] attachment devices.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For testing agency.
 - B. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.
 - C. Evaluation Reports: For linear-metal-ceiling framing systems.
 - D. Field quality-control reports.
- 1.9 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For finishes to include in maintenance manuals.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Linear-Metal-Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to [2] **<Insert number>** percent of quantity installed.

1.11 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockup of each type of linear metal ceiling as shown on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- D. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- E. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- F. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle ceiling components and accessories in a manner that prevents damage.

1.13 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings 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 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements" to design [seismic restraints and]attachment devices.
- B. Structural Performance: Exterior linear metal ceilings to withstand exterior exposure, the effects of gravity loads, and the following loads and stresses without showing permanent deformation of ceiling system components, including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:
 - 1. Wind Load: Uniform pressure [indicated on Drawings] <Insert requirements>, acting inward or outward.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): [120 deg F, ambient; 180 deg F material surfaces] <Insert requirements>.
- D. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions in accordance with [ASTM E580/E580M] [CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2"] [CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4"] [ASCE/SEI 7] <Insert requirements> and requirements of authorities having jurisdiction.
- E. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.

2.2 LINEAR METAL CEILINGS <Insert drawing designation>

- A. Metal Pans: Complying with ASTM E1264 for [Type XIII] [Type XX] and formed to snap on to carriers securely, without separate fasteners:
 - 1. Surface-Burning Characteristics: For metal pan assemblies, including backings, determined by testing in accordance with ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: [25] <Insert value> or less.
 - b. Smoke-Developed Index: [50] [55] <Insert value> or less.
 - 2. Metal: [Aluminum sheet, ASTM B209, alloy and temper recommended by producer and finisher for type of use and finish indicated] [Electrolytic zinc-coated steel sheet, ASTM A879/A879M, 04Z coating; surface treatment as recommended by finish manufacturer for type of use and painted finish indicated] <Insert requirements>.
 - 3. Form: [Perforated] [Nonperforated].
 - a. Perforation Pattern: [As indicated by manufacturers designation] <Insert requirements>.
 - 4. Noise Reduction Coefficient (NRC) Rating: Not less than [0.70] [0.75] [0.85] [1.00] <Insert requirements> when tested in accordance with ASTM C423.
 - 5. Backing: [Manufacturer's standard to provide NRC rating indicated for perforation pattern indicated] [Nonwoven black fabric] [Nonwoven black fabric with 1-inch-thick glass fiber, 1 lb/cu. ft. density, enclosed in black polyethylene] [1-inch-thick glass

- ~~fiber, 1 lb/cu. ft. density, enclosed in black polyethylene~~ <Insert requirements>.
6. ~~Pan Thickness: Not less than~~ [0.020 inch] [0.025 inch] [0.028 inch] [0.040 inch] <Insert dimension>.
 7. ~~Pan Edge Detail:~~ [Beveled] [Square] [Round] [Manufacturer's standard].
 8. ~~Pan Width:~~ [2-inch module width and 1-1/4-inch face width] [4-inch module width and 3-1/4-inch face width] [6-inch module width and 5-1/4-inch face width] [8-inch module width and 7-1/4-inch face width] [As indicated on Drawings] <Insert dimensions>.
 9. ~~Pan Depth:~~ [5/8 inch] [3/4 inch] [1 inch] [1-1/2 inches] [As indicated on Drawings] <Insert dimension>.
 10. ~~Metal-Pan Finish: Protected on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping and as follows:~~
 - a. ~~Aluminum Anodic Finish:~~ [Clear finish, AAMA 611, AMP 500 AA-M12C22A31, Class II, 0.010 mm or thicker] [Clear, mirror finish, AMP 500 AA-M21C12A212, 0.005 mm or thicker] <Insert requirements>.
 - b. ~~Color-Coated Finish: Manufacturer's standard~~ [powder-coat] baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
 - 1) ~~Color and Pattern:~~ [As selected by Architect from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's product designation] <Insert requirements>.
 - 2) ~~Light Reflectance (LR) Coefficient: Not less than~~ [0.61] [0.77] [0.81] <Insert value> LR when tested in accordance with ASTM E1477.
 - c. ~~Laminated-Film Finish: Provide~~ [manufacturer's standard] [vinyl] [PVC-free] <Insert requirements> film permanently bonded to metal pan with adhesive.
 - 1) ~~Color and Pattern:~~ [As selected by Architect from manufacturer's full range] [Match Architect's sample] [As indicated by manufacturer's product designation] <Insert requirements>.
 - d. ~~Wood-Veneer Finish:~~ [Match Architect's sample] [As indicated by manufacturer's product designation] [Wood veneer in species and finish selected by Architect from manufacturer's full range] <Insert requirements>; permanently bonded to metal pan with adhesive.
 - e. ~~Finish Bonding Adhesive: Manufacturer's standard that permanently bonds finish to aluminum.~~
- B. ~~Certified Wood: Wood products shall be certified as "FSC Pure" [or "FSC Mixed Credit"] according to FSC STD-01-00 and FSC STD-40-004.~~
- C. ~~Certified Wood: Wood products shall be certified as "FSC Pure" [or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.~~
- D. ~~Certified Wood: Wood products shall be labeled according to the AFPA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.~~
- E. ~~Certified Wood: Wood products shall [contain not less than 60 percent] [be made from] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by 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."~~
- F. ~~Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AFPA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.~~

- G. — Adhesives: Do not use adhesives that contain urea formaldehyde.
- H. — Adhesives: Use adhesives that meet 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."
- I. — Adhesives: Use adhesives that meet 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."
- J. — Adhesives: Do not use adhesives that contain urea formaldehyde.
- K. — Adhesives: Do not use adhesives that contain urea formaldehyde.
- L. — Pan Splices: Formed for snap fit into butt-cut pans, ~~[4 inches]~~ ~~[8 to 12 inches]~~ ~~<Insert dimension>~~ long.
1. — Finish: ~~[Manufacturer's standard]~~ ~~[Matte black]~~ ~~[Matching pan]~~ ~~<Insert requirements>~~.
- M. — End Caps: Manufacturer's standard material fabricated to fit and conceal exposed ends of pans.
1. — Finish: ~~[Manufacturer's standard]~~ ~~[Matte black]~~ ~~[Matching pan]~~ ~~<Insert requirements>~~.
- N. — Filler Strips: Manufacturer's standard, fabricated to close voids between pans.
1. — Type: ~~[Recessed]~~ ~~[Flush]~~ ~~[Integral extension of pan profile]~~ ~~[Expansion, for use with expansion carriers]~~ ~~[Slotted, for air diffusion]~~ ~~<Insert requirements>~~.
2. — Finish: ~~[Manufacturer's standard]~~ ~~[Matte black]~~ ~~[Matching pan]~~ ~~<Insert requirements>~~.
- O. — Moldings and Trim: Manufacturer's standard for exposed members, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
1. — For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.
- P. — Carrier Suspension System: Manufacturer's standard complying with requirements in ASTM C635/C635M for applications indicated; complete with carriers, splice sections, stabilizing components, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
1. — Material: ~~[ASTM A653/A653M, hot-dip galvanized, cold-rolled sheet steel, G60 coating designation]~~ ~~[ASTM A879/A879M, electrolytic zinc-coated, cold-rolled steel, 08Z coating designation]~~ ~~[ASTM B209 aluminum]~~ ~~<Insert requirements>~~.
2. — Structural Classification: ~~[Heavy-duty]~~ ~~<Insert requirements>~~ system.
3. — Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
4. — Flexible Radial Carriers: Manufacturer's standard radial carriers.
5. — Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
6. — Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers.
7. — Carrier Splices: Same metal, profile, and finish as for carriers.
8. — Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
9. — Carrier Finish: ~~[Flat black]~~ ~~<Insert requirements>~~.

2.32.2 CARRIER-SYSTEM HANGERS, BRACES, AND TIES

- A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **[5]** ~~<Insert safety factor>~~ times that imposed by ceiling construction as determined by testing in accordance with ASTM E488/E488M or ASTM E1512, as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: **[Cast-in-place]** **[Postinstalled expansion]** **[Postinstalled bonded]** anchors.
 - b. Corrosion Protection:
 - 1) Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
 - 2) Stainless steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
 - 3) Components fabricated from nickel-copper-alloy rods complying with ASTM B164 for UNS No. N04400 alloy.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to **[10]** ~~<Insert safety factor>~~ times that imposed by ceiling construction as determined by testing in accordance with ASTM E1190 conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Stainless Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
 4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provides not less than **[0.106-inch]** ~~[0.135-inch]~~ ~~<Insert dimension>~~ diameter wire.
- C. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Angle Hangers: Angles with legs not less than **7/8 inch** wide; formed from **0.04-inch** thick, galvanized-steel sheet complying with ASTM A653/A653M, **G60** coating designation; with bolted connections and **5/16-inch** diameter bolts.
- E. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.
- F. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A653/A653M, **G60** coating designation; size and profile as required to withstand wind load.

2.42.3 ACCESSORIES

- A. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors permitting upward or downward opening.

1. Size: [As indicated on Drawings] [24 inches square] <Insert requirements>.
- B. Air-Distribution Devices: Where indicated on Drawings, provide independently suspended air-distribution devices that are relocatable and adjustable from below finished ceiling, that do not interrupt ceiling components, and that are fully concealed by and integrated with ceiling system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of linear metal pans.
 1. Balance border widths at opposite edges of each ceiling.
 2. Avoid using less-than-half-width pans at borders.

3.3 INSTALLATION OF LINEAR METAL CEILINGS

- A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in 3 inches. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts[, power-actuated fasteners,] or postinstalled mechanical or adhesive anchors that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than **48 inches** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches** from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in **1-1/2 inches**. Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
1. Screw attach moldings to substrate at intervals of not more than **16 inches** o.c. and not more than **3 inches** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet**. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system carriers so they are aligned and securely interlocked with one another.
1. Install stabilizer channels, tees, and bars at regular intervals to stabilize carriers and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated.
 2. Remove and replace dented, bent, or kinked members.
- F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness.
- G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated on Drawings.
 2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
 - a. Install pans with butt joints **[aligned]** **[aligned, every other pan length]** **[staggered a minimum of 12 inches]** **[randomly aligned]** **[aligned as indicated on Drawings]** **<Insert requirements>** using internal pan splices.
 3. Install directionally textured or patterned metal pans in directions indicated.
 4. Where metal pan ends are visible, install end caps unless trim is indicated.
 5. Install filler strips where indicated **[on Drawings]** **<Insert requirements>**.
 6. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.
- H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: **[Owner will engage]** **[Engage]** a qualified special inspector to perform the following special inspections:

1. Suspended ceiling system.
 2. Hangers, anchors, and fasteners.
 3. <Insert special inspections>.
- B. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers, anchors, and fasteners to take place in successive stages, in test areas and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before pans have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for **200 lbf** of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for **440 lbf** of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Linear metal ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 095423

SECTION 095436 - SUSPENDED DECORATIVE GRIDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Suspended decorative aluminum grid units.~~
- ~~2. Suspended decorative steel grid units.~~

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Suspended decorative aluminum grid units.
2. Suspended decorative steel grid units.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

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

- D. Samples for Initial Selection: For units with factory-applied finishes.

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

1. Cell Grids: Set of [full-size] [~~12-inch~~ square] <Insert size> module Samples of each type, finish, and color.
2. Beam Grids: Set of ~~12-inch~~ long Samples of each type, finish, and color; a ~~12-inch~~ long spliced section; and a ~~6-inch~~ long per leg corner section.

- F. Delegated Design Submittals: For design of [seismic restraints and] attachment devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each

other, using input from installers of the items involved:

1. Lighting fixtures.
2. Air outlets and inlets.
3. Speakers.
4. Sprinklers.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Suspended Decorative Grids: Quantity of each suspended decorative grid component, exposed molding, and trim equal to [2] **<Insert number>** percent of quantity installed.

1.7 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 mockup of typical ceiling area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver suspended decorative grid components to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

- B. Handle suspended decorative grids and accessories to avoid damaging units and finishes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **[seismic restraints and]** attachment devices.

- B. 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.

2.2 PRODUCTS, GENERAL

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** ~~<Insert value>~~ percent.
- B. Sheet Metal: Selected for surface flatness, smoothness, and freedom from surface blemishes where exposed to view in finished unit. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, variations in flatness exceeding those permitted by referenced standards for stretcher-leveled metal sheet, stains, discolorations, or other imperfections.
- C. Grid Fabrication: Components are formed from metal indicated. Manufacturer's standard units of size, shape, and profile indicated; finished to comply with requirements indicated. **[Provide cells factory assembled into modular panel.]**
- D. Cover Profiles and Trim: Provide manufacturer's standard cover profiles and trim for exposed members, and as indicated or required, for edges of grids, at changes in ceiling height, and for other conditions, of same metal and finish as suspended decorative grids.
- E. Metal Suspension-System Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C635/C635M requirements. Provide systems complete with runners or beams, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, web covers, load-resisting struts, fixture filler pans, clips and adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
- F. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318, greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.
 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated in accordance with ICC-ES AC70, greater than or equal to the design load, as determined by testing in accordance with ASTM E1190 conducted by a qualified testing agency.
- G. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at 3 times hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than **[0.106-inch]** ~~[0.135-inch]~~ diameter wire.
- H. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- I. Angle Hangers: Angles with legs not less than **7/8 inch** wide; formed with **0.04-inch** thick, galvanized-steel sheet complying with ASTM A653/A653M, **690** coating designation; with bolted connections and **5/16-inch** diameter bolts.
- J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

- K. Exposed Metal Edge Moldings, Covers, Trim, and Fixture Filler Panels: Provide exposed members as indicated or required to conceal edges of and penetrations through ceiling, to conceal edges of beams, to cover runner webs, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching suspended decorative grids unless otherwise indicated.

- 1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.3 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Measure each installation area and establish layout of suspended decorative grids to balance border widths at opposite edges of each space. Comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED DECORATIVE GRIDS

- A. Install suspended decorative grids to comply with ASTM C636/C636M and seismic design requirements indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within plenum that are not part of supporting structure or of grid suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for structure to which hangers are attached and for hanger type involved.
 - 5. Do not support grids directly from permanent metal forms or floor deck. Fasten hangers to expansion anchors or power-

- actuated anchors that extend through forms into concrete.
6. Do not attach hangers to steel deck tabs.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of **[three]** **[four]** tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with expansion anchors.
- D. Install edge moldings and trim of type indicated at perimeter of each suspended decorative grid and where necessary to conceal edges of grids.
 1. Screw attach moldings to substrate at intervals not more than **16 inches** o.c. and not more than **3 inches** from ends, level with ceiling system to a tolerance of **1/8 inch in 12 feet**. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspended decorative grids in coordination with suspension system and exposed moldings and trim. Comply with installation tolerances in accordance with CISCA's "Metal Ceilings Technical Guidelines."
 1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
 2. Fit adjoining units to form flush, tight joints.
 3. Where grid edges are visible, install cover profiles unless other trim is indicated.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: **[Owner will engage]** **[Engage]** a qualified special inspector to perform the following special inspections:
 1. Seismic design compliance.
 2. **<Insert special inspections>**.
- B. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections on each floor when installation of the suspended decorative grid on each floor is 20 percent complete. Do not proceed with installing the remainder of the grid on each floor until results in the test area for the floor show compliance with requirements.
 1. Hanger-Wire Attachment: Within each test area, testing agency selects one of every 10 power-actuated anchors and expansion anchors used to attach hangers to concrete and tests them for **[100 lbf]** **[200 lbf]** **<Insert load>** of tension.
 2. Bracing-Wire Attachment: Within each test area, testing agency selects one of every two expansion anchors used to attach bracing wires to concrete and tests them for **[100 lbf]** **[440 lbf]** **<Insert load>** of tension.
 3. When tested anchors do not comply with requirements, testing agency tests those anchors not previously tested until 20 pass consecutively and then resumes initial testing frequency.
- D. Suspended decorative grid anchors will be considered defective if they do not pass tests and inspections.
- E. Prepare tests and inspection reports.

3.5 CLEANING

- A. Clean exposed surfaces of suspended decorative grids, including trim and edge moldings, after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace grid components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and deformed grids.

END OF SECTION 095436

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Solid vinyl floor tile.~~
- ~~2. Rubber floor tile.~~
- ~~3. Vinyl composition floor tile.~~
- ~~4. Resilient terrazzo 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. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.
8. Environmental Product Declaration: For each product.
9. Health Product Declaration: For each product.
10. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
11. Environmental Product Declaration: For each product.
12. Environmental Product Declaration: For each product.
13. Environmental Product Declaration: For each product.
14. Third-Party Certifications: For each product.
15. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: For each type of resilient floor tile.

1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

D. Samples: Full-size units of each color, texture, and pattern of floor tile required.

1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **[9 inches]** <Insert dimension> long, of each color required.

- E. Samples for Initial Selection: For each type of floor tile indicated.
- F. Samples for Verification: Full-size units of each color and pattern of floor tile required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than **[9 inches]** <Insert dimension> long, of each color required.
- G. Welded-Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of **[6-by-9-inch]** <Insert dimensions> Sample applied to a rigid backing and prepared by Installer for this Project.
- H. Product Schedule: For floor tile. [**Use same designations indicated on Drawings.**]

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials[, **from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish one box for every **[50]** <Insert number> boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum **100 sq. ft.** for each type, color, and pattern **[in locations indicated]** **[in locations directed by Architect]** <Insert locations>.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless

Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F** or more than **90 deg F**. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **[70 deg F]** <Insert temperature> or more than **[95 deg F]** <Insert temperature>, in spaces to receive floor tile during the following periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **[55 deg F]** <Insert temperature> or more than **[95 deg F]** <Insert temperature>.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

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.
- B. Flooring products shall 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."
- C. Flooring products shall 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."
- D. Flooring products shall 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." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

- E. Flooring products shall 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."
- F. Flooring products shall 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."

~~2.2~~ ~~RESILIENT TERRAZZO FLOOR TILE~~ ~~<Insert drawing designation>~~

- A. ~~Thickness: [1/8 inch] [3/16 inch].~~
- B. ~~Size: [12 by 12 inches] [24 by 24 inches] [24 by 48 inches].~~
- C. ~~Seamless Installation Method: Chemically bonded.~~
- D. ~~Accessories:~~
 - 1. ~~Base: [3 inches] [4 inches] [6 inches] tall.~~
 - a. ~~Type: [Sanitary, coved] [Straight].~~
 - 2. ~~Divider strips.~~
 - 3. ~~<Insert accessory>.~~
- E. ~~Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's samples] <Insert colors and patterns>.~~

2.32.2 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. Adhesives shall have a VOC content of [50] [60] ~~<Insert value>~~ g/L or less.
 - 2. Adhesive 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."
 - 3. Adhesive 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."
 - 4. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - 5. Adhesive 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."
 - 6. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

C. Seamless-Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Colors: **[As selected by Architect from manufacturer's full range to contrast with floor tile] [Match floor tile] <Insert colors>.**
2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
3. Chemical-Bonding Compound shall have a VOC content of **[510] <Insert value>** g/L or less.
4. Chemical-Bonding Compound 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."
5. Chemical-Bonding Compound 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."
6. Chemical-Bonding Compound 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
7. Chemical-Bonding Compound 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."
8. Chemical-Bonding Compound 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

E. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade recommended in writing by floor tile manufacturer to suit resilient terrazzo floor tile.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant 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."
3. Sealant 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."
4. Sealant 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Sealant 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."
6. Sealant 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

7. Joint-Sealant Color: [White] [As selected by Architect from manufacturer's full range to match floor tile] [Match floor tile] <Insert color>.

- F. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Products recommended by floor tile manufacturer for resilient terrazzo floor tile.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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] [10] <Insert number> pH.
4. Moisture Testing: Perform tests so that each test area does not exceed [200 sq. ft.] [1000 sq. ft.] <Insert area>, 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.] <Insert rate> in 24 hours.
- b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [75] <Insert number> percent relative humidity level measurement.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. 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.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 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 **[square with room axis]** **[at a 45-degree angle with room axis]** **[in pattern indicated]** **<Insert requirements>**.
- 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 running in one direction]** **[with grain direction alternating in adjacent tiles (basket-weave pattern)]** **[in pattern of colors and sizes indicated]**.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. 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.
- G. 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.
- H. 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.
- I. Seamless Installation:
 1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.
- J. Resilient Terrazzo Accessories: Install according to manufacturer's written instructions.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply [one] [two] [three] <Insert requirements> coat(s).
- E. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
 - 1. Sealer: Apply two base coats of liquid sealer.
 - 2. Finish: Apply [two] [three] <Insert requirements> coats of liquid floor finish.
- G. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ~~Primers.~~
2. ~~Finish coatings.~~
3. ~~Floor sealers and paints.~~

B. ~~Related Requirements:~~

1. ~~[Section 051200 "Structural Steel Framing"] [Section 051213 "Architecturally Exposed Structural Steel Framing"] for shop priming of metal substrates.~~
2. ~~Section 055000 "Metal Fabrications" for shop priming metal fabrications.~~
3. ~~Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.~~
4. ~~Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.~~
5. ~~Section 055213 "Pipe and Tube Railings" for shop [priming] [painting] pipe and tube railings.~~
6. ~~[Section 055313 "Bar Gratings"] [Section 055316 "Plank Gratings"] [Section 055319 "Expanded Metal Gratings"] for shop priming metal gratings.~~
7. ~~Section 099300 "Staining and Transparent Finishing" for surface preparation and application of wood stains and transparent finishes on exterior wood substrates.~~
8. ~~Section 099600 "High-Performance Coatings" for tilelike coatings.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

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. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life-Cycle Assessment: For each product.
10. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

- C. Samples: For each type of topcoat product.
- D. Samples for Initial Selection: For each type of topcoat product.
- E. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, **8 inches** square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- F. Product Schedule: 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 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint Products: [5] <Insert number> percent, but not less than [**1 gal.**] <Insert value> of each material and color applied.

1.4 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.**
 - 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.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F.**
 - 1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and Concrete Masonry Units): 12 percent.
 4. Wood: 15 percent.
 5. Portland Cement Plaster: 12 percent.
 6. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is dry and sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.
- F. 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 applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer[.] [**but not less than the following:**]
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
 - 3. SSPC-SP 7/NACE No. 4.
 - 4. SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 - 2. Sand surfaces that will be exposed to view, and remove sanding dust.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint **[both sides]** **[exterior side]** and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

6. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards[**and switch gear**].
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. **<Insert requirements>**.

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 instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 3. Allow empty paint cans to dry before disposal.
 4. Collect waste paint by type and deliver to recycling or collection facility.
- 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 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

- 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: [Exterior, alkali-resistant, water-based primer] [Matching topcoat].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
- 2. Latex over Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: Textured latex coating, flat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
- 3. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [low sheen].
- 4. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
- 5. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].

B. Concrete Substrates, Traffic Surfaces:

- 1. Latex Floor Paint System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Latex floor paint, low gloss.
- 2. Latex Deck Coating System <Insert drawing designation>:

- a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Latex deck coating.
3. Alkyd Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Alkyd floor enamel, gloss.
4. Clear, Water-Based Sealer System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Water-based, concrete-floor sealer.
5. Clear, Solvent-Based Sealer System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Solvent-based, concrete-floor sealer.
- C. Clay Masonry Substrates:
 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 2. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [low sheen].
 3. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
 4. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
- D. Concrete Masonry Unit Substrates:

1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex block filler.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 2. Latex over Alkali-Resistant Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 3. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [low sheen].
 4. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
 5. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex block filler.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
- E. Steel and Iron Substrates:
1. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: [Zinc-rich, inorganic primer] [Alkyd metal primer] [Epoxy metal primer] [Shop primer specified in Section in which substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 2. Water-Based, Light Industrial Coating over Epoxy System <Insert drawing designation>:
 - a. Prime Coat: Epoxy metal primer.
 - b. Intermediate Coat: High-build epoxy paint, low gloss.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd metal primer] [Surface-tolerant metal primer] [Shop primer specified in Section in which substrate is specified].
 - b. Intermediate Coat: Matching topcoat.

- c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
 - 4. Quick-Drying Enamel System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying, alkyd metal primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Quick-drying alkyd enamel, [semigloss] [gloss].
 - 5. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd metal primer] [Shop primer specified in Section in which substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Aluminum paint.
- F. Galvanized-Metal Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based, galvanized-metal primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: [Water-based, galvanized-metal primer] [Epoxy metal primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
- G. Aluminum Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying aluminum primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying aluminum primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 - 3. Alkyd System <Insert drawing designation>:
 - a. Pretreatment Coat: Vinyl wash primer.
 - b. Prime Coat: Quick-drying aluminum primer.
 - c. Intermediate Coat: Matching topcoat.
 - d. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- H. Copper Substrates:

1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying aluminum primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying aluminum primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 3. Alkyd System <Insert drawing designation>:
 - a. Pretreatment Coat: [Vinyl wash] [Quick-drying aluminum] primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- I. Stainless Steel Substrates:
1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Quick-drying aluminum primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Vinyl wash primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- J. Glue-Laminated Wood Substrates:
1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 2. Latex over Alkyd/Oil Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.

- c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
- 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- K. Exposed Wood-Framing Substrates:
 - 1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- L. Dressed-Lumber Substrates: [Trim] [Architectural woodwork] [Doors] [Windows] [Board siding] [Railings] [Fences] <Insert requirements>.
 - 1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 3. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [semigloss] [gloss].
 - 4. Alkyd System <Insert drawing designation>:

- a. Prime Coat: Exterior, alkyd/oil wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].

M. Wood Shingle and Shake Siding Substrates:

1. Latex over Latex Primer System <Insert drawing designation>:

- a. Prime Coat: Exterior, latex wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].

2. Latex over Alkyd Primer System <Insert drawing designation>:

- a. Prime Coat: Exterior, alkyd/oil wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].

3. Alkyd System <Insert drawing designation>:

- a. Prime Coat: Exterior, alkyd/oil wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].

N. Wood-Based Panel Substrates:

1. Latex over Latex Primer System <Insert drawing designation>:

- a. Prime Coat: Exterior, latex wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].

2. Latex over Alkyd Primer System <Insert drawing designation>:

- a. Prime Coat: Exterior, alkyd/oil wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].

3. Alkyd System <Insert drawing designation>:

- a. Prime Coat: Exterior, alkyd/oil wood primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].

O. Wood-Board, Traffic-Surface Substrates:

1. Latex Floor Paint over Latex Primer System <Insert drawing designation>:

- a. Prime Coat: Exterior, latex wood primer.
- b. Intermediate Coat: Matching topcoat.

- c. Topcoat: Latex floor paint, low gloss.
- 2. Latex Floor Paint over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Latex floor paint, low gloss.
- 3. Latex Deck Coating System <Insert drawing designation>: For plywood decks.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommending in writing by topcoat manufacturer.
 - c. Topcoat: Latex deck coating.
- 4. Alkyd Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Alkyd floor enamel, gloss.
- 5. Alkyd Floor Enamel over Wood Preservative System <Insert drawing designation>:
 - a. Preservative Coat: Exterior wood preservative.
 - b. Prime Coat: Matching topcoat.
 - c. Intermediate Coat: Matching topcoat.
 - d. Topcoat: Alkyd floor enamel, gloss.
- P. Cementitious Composition Board Substrates: [Siding] [Trim] [Panels] <Insert requirements>.
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 3. Alkyd System over Latex Wood Primer System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
 - 4. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.

- b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
 - 5. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 - 6. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- Q. Fiberglass Substrates:
- 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 - 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
- R. Plastic-Trim-Fabrication Substrates:
- 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: [Solvent] [Water]-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
 - 2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: [Solvent] [Water]-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
 - 3. Alkyd System <Insert drawing designation>:

- a. Prime Coat: Solvent-based bonding primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].

S. Portland Cement Plaster Substrates:

- 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: [Matching topcoat] [Exterior, alkali-resistant, water-based primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
- 2. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
- 3. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].

T. Exterior Gypsum Board Substrates:

- 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer, reduced in accordance with manufacturer's written instructions for substrate and topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
- 2. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [low sheen].
- 3. High-Build Latex System <Insert drawing designation>: Dry film thickness of not less than **10 mils**.
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Exterior, high-build latex paint.
- 4. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Exterior, latex wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].

U. Exterior Canvas Substrates:

1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
2. Water-Based, Light Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, [low sheen] [semigloss] [gloss].
3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Exterior latex paint, flat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
4. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: Exterior latex paint, flat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Aluminum paint.

V. Bituminous-Coated Substrates:

1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based, rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, [flat] [low sheen] [semigloss] [gloss].
2. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [low sheen].
3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Water-based, rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior alkyd enamel, [flat] [semigloss] [gloss].
4. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: Water-based, rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.

- c. Topcoat: Aluminum paint.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Primers.~~
- ~~2.1. Water-based finish coatings.~~
- ~~3.2. Solvent-based finish coatings.~~
- ~~4. Floor sealers and paints.~~
- ~~5. Dry fall coatings.~~

B. ~~Related Requirements:~~

- ~~1. [Section 051200 "Structural Steel Framing"] [Section 051213 "Architecturally Exposed Structural Steel Framing"] for shop priming structural steel.~~
- ~~2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.~~
- ~~3. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.~~
- ~~4. Section 055116 "Metal Floor Plate Stairs" for shop priming metal floor plate stairs.~~
- ~~5. Section 055119 "Metal Grating Stairs" for shop priming metal grating stairs.~~
- ~~6. Section 055213 "Pipe and Tube Railings" for shop [priming] [painting] pipe and tube railings.~~
- ~~7. [Section 055313 "Bar Gratings"] [Section 055316 "Plank Gratings"] [Section 055319 "Expanded Metal Gratings"] for shop priming metal gratings.~~
- ~~8. Section 099300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.~~
- ~~9. Section 099600 "High-Performance Coatings" for tile-like coatings.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

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.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.

9. Third-Party Certifications: For each product.
 10. Third-Party Certified Life Cycle Assessment: For each product.
 11. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.
- C. Samples: For each type of topcoat product.
- D. Samples for Initial Selection: For each type of topcoat product.
- E. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
1. Submit Samples on rigid backing, **8 inches** square.
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- F. Product Schedule: 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 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint Products: [5] **<Insert number>** percent, but not less than [**1 gal.**] **<Insert number>** of each material and color applied.

1.4 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.**
 - 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.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F**.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Fiber-Cement Board: 12 percent.
 - 3. Masonry (Clay and CMUs): 12 percent.
 - 4. Wood: 15 percent.
 - 5. Gypsum Board: 12 percent.
 - 6. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. 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 applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer[.] [**but not less than the following:**]
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
 - 3. SSPC-SP 7/NACE No. 4.
 - 4. SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. 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. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - i. **<Insert mechanical items to be painted>**.
 - 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
 - i. **<Insert requirements>**.
 - 3. 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.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
 - 4. Collect waste paint by type and deliver to recycling or collection facility.
- 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. Concrete Substrates, Nontraffic Surfaces:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: [Alkali-resistant, water-based primer] [Matching topcoat].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior latex paint, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Latex over Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: Textured latex coating, flat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior latex paint, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. Latex Aggregate System <Insert drawing designation>:

- a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Textured latex coating, [flat] [nonflat].
 4. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 5. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 6. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 7. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior alkyd, [flat] [eggshell] [semigloss] [gloss].
 8. Concrete Stain System <Insert drawing designation>:
 - a. First Coat: Matching topcoat.
 - b. Topcoat: Interior concrete stain.
- B. Concrete Substrates, Traffic Surfaces:
1. Latex Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Latex floor paint, low gloss.
 2. Alkyd Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Alkyd floor enamel, gloss.
 3. Concrete Stain System <Insert drawing designation>:
 - a. First Coat: Matching topcoat.

- b. Topcoat: Interior concrete stain.
 - 4. Water-Based Concrete Floor Sealer System <Insert drawing designation>:
 - a. First Coat: Matching topcoat.
 - b. Topcoat: Water-based concrete floor sealer.
 - 5. Solvent-Based Concrete Floor Sealer System <Insert drawing designation>:
 - a. First Coat: Matching topcoat.
 - b. Topcoat: Solvent-based concrete floor sealer.
- C. Cement Board Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 - 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
- D. Clay Masonry Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.

- b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Textured latex coating, [flat] [nonflat].
 - 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 - 5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 - 6. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- E. CMU Substrates:
- 1. Latex System <Insert drawing designation>:
 - a. Block Filler: Interior/exterior latex block filler.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Latex Aggregate System <Insert drawing designation>:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Textured latex coating, [flat] [nonflat].
 - 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Block Filler: Interior/exterior latex block filler.

- b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Block Filler: Interior/exterior latex block filler.
 - b. Prime Coat: Alkali-resistant, water-based primer.
 - c. Intermediate Coat: Matching topcoat.
 - d. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 - 5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Block Filler: Interior/exterior latex block filler.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 - 6. Alkyd System <Insert drawing designation>:
 - a. Block Filler: Interior/exterior latex block filler.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- F. Steel Substrates:
- 1. Latex System, Alkyd Primer <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Latex over Shop-Applied Quick-Drying Shop Primer System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for shop application.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].

5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Primer, rust-inhibitive, water based.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
6. Water-Based Light-Industrial Coating System over Epoxy Primer System <Insert drawing designation>:
 - a. Prime Coat: Anticorrosive epoxy primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
7. Water-Based Dry-Fall System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Topcoat: [Dry fall, latex, flat] [Water-based dry fall for galvanized steel, flat] [Dry fall, latex, eggshell] [Dry fall, latex, semigloss].
8. Water-Based Dry Fall over Shop-Applied Quick-Drying Shop Primer System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for shop application.
 - b. Topcoat: [Dry fall, latex, flat] [Water-based dry fall for galvanized steel, flat] [Dry fall, latex, eggshell] [Dry fall, latex, semigloss].
9. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
10. Alkyd over Surface-Tolerant Primer System <Insert drawing designation>:
 - a. Prime Coat: Surface-tolerant metal primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
11. Quick-Dry Enamel System <Insert drawing designation>:
 - a. Prime Coat: Alkyd quick-dry primer for metal.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
12. Alkyd Dry-Fall System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Topcoat: Alkyd, dry fall, [flat] [eggshell] [semigloss].

13. Alkyd Dry Fall over Quick-Drying Primer System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for shop application.
 - b. Topcoat: Alkyd, dry fall, [flat] [eggshell] [semigloss].
 14. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: [Alkyd quick-dry primer for metal] [Alkyd anticorrosive primer] [Shop primer specified in Section where substrate is specified].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Aluminum paint.
- G. Galvanized-Metal Substrates:
1. Latex System <Insert drawing designation>:
 - a. Prime Coat: [Cementitious galvanized primer] [Water-based galvanized primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Cementitious galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 5. Water-Based Dry-Fall System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Topcoat: Water-based dry fall for galvanized steel, flat.
 6. Alkyd over Cementitious Primer System <Insert drawing designation>:
 - a. Prime Coat: Cementitious galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
 7. Alkyd Dry-Fall System (Cementitious Primer) <Insert drawing designation>:

- a. Prime Coat: Cementitious galvanized primer.
 - b. Topcoat: Alkyd, dry fall, [flat] [eggshell] [semigloss].
- 8. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: Cementitious galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Aluminum paint.
- H. Aluminum (Not Anodized or Otherwise Coated) Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 - 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 - 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Primer, [Vinyl wash primer] [Quick-dry primer for aluminum].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- I. Copper Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:

- a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
- 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
- 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Quick-dry primer for aluminum.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating coating, [eggshell] [semigloss] [gloss].
- 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Vinyl wash primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- J. Stainless Steel Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 - 3. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: [Solvent-based bonding primer] [Quick-dry primer for aluminum].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating coating, [eggshell] [semigloss] [gloss].
 - 4. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Vinyl wash primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- K. Exposed Wood Framing:

1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- L. Finish Carpentry: [Wood trim] [Doors] [Windows] [and] [Wood board paneling].
1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].

4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 6. Water-Based Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Water-based alkyd, [gloss] [high gloss].
 7. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- M. Architectural Woodwork: [Wood paneling] [and] [casework].
1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].

5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 6. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- N. Wood Traffic Surfaces: [Floors] [and] [stairs].
1. Latex Porch and Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Latex floor paint, low gloss.
 2. Alkyd Floor Enamel System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Alkyd floor enamel, gloss.
- O. Wood Shingles and Shakes:
1. Latex over Latex Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Latex over Alkyd Primer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior, alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- P. Fiberglass Substrates:
1. Latex System <Insert drawing designation>:

- a. Prime Coat: [Water-based bonding primer] [Solvent-based bonding primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: [Water-based bonding primer] [Solvent-based bonding primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: [Water-based bonding primer] [Solvent-based bonding primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: [Water-based bonding primer] [Solvent-based bonding primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: [Water-based bonding primer] [Solvent-based bonding primer].
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- Q. Plastic Substrates:
1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 4. Water-Based Light-Industrial Coating System <Insert drawing designation>:

- a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 - 5. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- R. Spray-Textured Ceiling Substrates:
- 1. Latex, Flat System: Spray applied <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Topcoat: Interior, latex, flat.
 - 2. Latex System: Spray applied <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. Latex over Alkyd Sealer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 4. Alkyd, Flat System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Topcoat: Interior, alkyd, flat.
 - 5. Alkyd over Alkyd Sealer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- S. [Gypsum Board] [and] [Plaster] Substrates:
- 1. Latex over Latex Sealer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Latex over Alkyd Primer System (for Plaster Only) <Insert drawing designation>:

- a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
 5. Water-Based Light-Industrial Coating System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, water-based, light-industrial coating, [eggshell] [semigloss] [gloss].
 6. Alkyd over Latex Sealer System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
- T. Acoustic Panels and Tiles:
1. Latex, Flat System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Topcoat: Interior, latex, flat.
 2. Latex over Alkyd Sealer System <Insert drawing designation>:
 - a. Prime Coat: Interior alkyd primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 3. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 4. High-Performance Architectural Latex System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.

- b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, high-performance architectural coating, [low sheen] [eggshell] [satin] [semigloss].
- 5. Alkyd, Flat System <Insert drawing designation>:
 - a. Prime Coat: Matching topcoat.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, flat.
- U. [Cotton or Canvas] [and] [ASJ] Insulation-Covering Substrates: Including [pipe and duct coverings] <Insert description>.
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Institutional Low-Odor/VOC Latex System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 3. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
 - 4. Aluminum Paint System <Insert drawing designation>:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Aluminum paint.
- V. Bituminous-Coated Substrates:
 - 1. Latex System <Insert drawing designation>:
 - a. Prime Coat: Water-based rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, [flat] [low sheen] [eggshell] [satin] [semigloss] [gloss].
 - 2. Alkyd System <Insert drawing designation>:
 - a. Prime Coat: Water-based rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, alkyd, [flat] [eggshell] [semigloss] [gloss].
 - 3. Aluminum Paint System <Insert drawing designation>:

- a. Prime Coat: Water-based rust-inhibitive primer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat: Aluminum paint.

END OF SECTION 099123

SECTION 099653 - ELASTOMERIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

~~1. Elastomeric coatings.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Indicate VOC content.

B. Samples for Initial Selection: For each type of elastomeric coating.

C. Samples for Verification: For each type of elastomeric coating indicated and in each color and gloss.

1. Submit Samples on same type of substrate as that to receive application, **8 inches** square.
2. Apply coats on Samples in steps to show each separate coat, including primers and block fillers as applicable.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

E. 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. Environmental Product Declaration (EPD): For each product.
6. Environmental Product Declaration (EPD): For each product.
7. Environmental Product Declaration (EPD): For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life-Cycle Assessment: For each product.
10. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials[, **from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quantity: Furnish an additional [5] <Insert number> percent but not less than [1 gal.] <Insert quantity> of each material, color, and texture applied.

1.4 MOCKUPS

- A. 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.
 - 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.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 90 deg F unless otherwise permitted by manufacturer's written instructions.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Water penetration through the coating.
 - b. Deterioration of coating beyond normal weathering.
 - c. <Insert failure modes>.
2. Warranty Period: [Five] [10] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of work.
- B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.
- C. Begin coating no sooner than [28] <Insert number> days after substrate is constructed and is visually dry on both sides.
- D. Verify that substrate is within the range of alkalinity recommended by manufacturer.
- E. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
- B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
 2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.
- D. Crack Repair: Fill cracks in accordance with manufacturer's written instructions before coating surfaces.

3.3 APPLICATION OF ELASTOMERIC COATINGS

- A. Apply elastomeric coatings in accordance with manufacturer's written instructions.
 - 1. Use equipment and techniques best suited for substrate and type of material being applied.
 - 2. Coat surfaces behind movable items the same as similar exposed surfaces.
 - 3. Apply each coat separately in accordance with manufacturer's written instructions.
- B. Primers: Apply at a rate to ensure complete coverage.
- C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.
- D. Elastomeric Finish Coat(s): ~~[Minimum two coats with a total dry film thickness of 16 to 18 mils] [Minimum one coat with a total dry film thickness of 7 to 10 mils] [Manufacturer's recommended number of coats and total dry film thickness for condition of substrate]~~
<Insert requirement>.
- E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- F. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.
- G. Apply coatings 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.
- H. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.
- I. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.43.3 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following testing procedures:
 - 1. Owner will engage the services of a qualified testing agency to sample materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of materials with product requirements.
 - 3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.
- B. Field Testing and Inspection: Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

3.53.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating 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, touch up and restore damaged or defaced coated surfaces.

3.63.5 ELASTOMERIC COATING SCHEDULE

- A. Concrete Substrates:
 - 1. Elastomeric Coating System:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Elastomeric, pigmented, exterior, water-based, [flat] [nonflat] coating.
 - 1) <Insert manufacturer's name; product name or designation>.
- B. Concrete Unit Masonry Substrates:
 - 1. Elastomeric Coating System:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Block Filler: As recommended in writing by topcoat manufacturer.
 - c. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - d. Topcoat: Elastomeric, pigmented, exterior, water-based, flat coating.
 - 1) <Insert manufacturer's name; product name or designation>.
- C. Stucco Substrates:
 - 1. Elastomeric Coating System:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - c. Topcoat: Elastomeric, pigmented, exterior, water-based, [flat] [nonflat] coating.
 - 1) <Insert manufacturer's name; product name or designation>.

END OF SECTION 099653

SECTION 099726 - CEMENTITIOUS COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of cementitious coating systems on the following substrates:

1. [Exterior] [Interior] concrete.
2. [Exterior] [Interior] concrete masonry units.
3. [Exterior] [Interior] brick.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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.
- C. Samples for Initial Selection: For each type of topcoat product.
- D. Samples for Verification: In each color and gloss of topcoat.
1. Submit Samples on [rigid backing] [actual substrate], not less than **8 inches** square[, with mortar joint in center].
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each cementitious coating, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for each product formulation.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are from same production run (batch mix) as materials applied and that are packaged with protective covering for storage and identified with labels describing contents.
1. Quantity: Furnish an additional [5] <Insert number> percent of each color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of coating 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 [actual substrate of each type] <Insert requirements> to represent surfaces and conditions for application of coating.
 - a. Wall Surfaces: Prepare Samples of at least [100 sq. ft.] <Insert dimension>.
 - 2. Apply mockups after permanent lighting and other environmental services have been activated.
 - 3. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of colors selected by Architect at no added cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Contents by volume, for pigment and vehicle constituents.
 - 4. Application instructions.
 - 5. Color name and number.
 - 6. Handling instructions and precautions.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
 - 1. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS
PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
- D. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
 - 1. Cracks Larger Than **1/32 Inch**: Cut out static cracks, voids, or honeycombing larger than **1/32 inch** and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

- A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.
 - 1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated and surface dry at time of application.
 - 2. Brushes: Use Tampico or masonry brushes best suited for material being applied.
 - 3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.

- B. Apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. First Coat: Apply polymer-modified cementitious coating material at the rate of **2 lb/sq. yd.** to achieve a total cured thickness of **25 mils.**
 - 2. Second Coat: Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd.** to achieve a total cured thickness of **15 mils.**
 - 3. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
- C. On previously coated surfaces, apply coating to achieve material thickness as recommended in writing by manufacturer, but not less than the following:
 - 1. Apply polymer-modified cementitious coating material at the rate of **1 lb/sq. yd.** to achieve a total cured thickness of **15 mils.**
 - 2. Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
- D. Brush Application: Brush out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.
- E. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

3.4 FIELD QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coating operations are being conducted:
 - 1. Owner will engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance with product requirements specified.
 - 3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

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

3.6 CEMENTITIOUS COATING SCHEDULE

A. Above-Grade Concrete and Masonry:

1. Polymer-Modified Cementitious Coating:

- a. Prime Coat: As recommended in writing by topcoat manufacturer.
- b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
- c. Topcoat: Polymer-modified cementitious coating.

1) <Insert manufacturer's name; product name or designation>.

END OF SECTION 099726

SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Plastic-laminate-clad casework.~~
- ~~2.1. Hardware and accessories.~~

~~B. Related Requirements:~~

- ~~1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.~~
- ~~2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.~~
- ~~3. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-clad casework.~~
- ~~4. Section 123553.16 "Plastic-Laminate Laboratory Casework."~~
- ~~5. Section 123623.13 "Plastic-Laminate-Clad Countertops."~~

1.2 DEFINITIONS

- A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
- B. Keying Conference: Conduct conference at [Project site] <Insert location>. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

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

1.5 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-clad casework.
2. Hardware and accessories.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 3. Environmental Product Declaration (EPD): For each product.
 4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
 5. Environmental Product Declaration: For each product.
 6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
 7. Environmental Product Declaration: For each product.
 8. Environmental Product Declaration: For each product.
 9. Third-Party Certifications: For each product.
 10. Third-Party Certified Life Cycle Assessment: For each product.
 11. Environmental Product Declaration (EPD): Provide one of the following EPDs: critically reviewed life-cycle assessment complying with ISO 14044; internally reviewed, product-specific Type III EPD; third-party-verified, industrywide Type III EPD.
 12. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 13. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 14. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 15. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 16. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 17. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 18. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 19. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
 20. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
 21. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
 22. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
 23. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings: For plastic-laminate-clad casework.
1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
 2. Indicate types and sizes of casework.
 3. Indicate manufacturer's catalog numbers for casework.
 4. Show fabrication details, including types and locations of hardware.
 5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
 6. Apply [AWI's Quality Certification] [WI's Certified Compliance] Program label to Shop Drawings.
- D. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.
- E. Samples: For casework and hardware finishes.
- F. Samples for Initial Selection: For casework and hardware finishes.
- G. Samples for Verification: For the following:
1. Plastic Laminates: [8 by 10 inches] [12 by 12 inches] <Insert dimensions>, for each type, color, pattern, and surface finish required.

- a. Provide one Sample applied to core material with specified edge material applied to one edge.
2. Thermally Fused Laminate Panels: [8 by 10 inches] [12 by 12 inches] <Insert dimensions>, for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
3. Base Cabinet: One full-size, [16-inch] <Insert dimension> wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
4. Wall Cabinet: One full-size, [12-inch] <Insert dimension> wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
5. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their locations.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [casework manufacturer] [and] [Installer].
- B. Sample Warranty: For special warranty.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: [AWI's Quality Certification Program] [WI's Certified Compliance Program] certificates.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- E. Installer Qualifications: [An authorized representative who is trained and approved by manufacturer] [and] [Licensed participate in AWI's Quality Certification Program] [Licensed participate in WI's Certified Compliance Program].

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework 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 remainder of construction period. [**Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."**]
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.
- D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - 2. Warranty Period: **[Five]** <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

- A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: **[Premium]** **[Custom]** **[Economy]**.
 - 2. Provide labels and certificates from **[AWI]** **[WI]** certification program indicating that casework complies with requirements of grades specified.
 - a. This Project has been registered with AWI as AWI's Quality Certification Program Number <Insert number>.
 - b. Contractor to register the Work under this Section with AWI's Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.
- B. Regional Materials: Wood products shall be manufactured within **500 miles** of Project site from materials that have been extracted,

harvested, or recovered, as well as manufactured, within **500 miles** of Project site.

- C. Regional Materials: Wood products shall be manufactured within **500 miles** of Project site.
- D. Regional Materials: Wood products shall be manufactured within **100 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **100 miles** of Project site.
- E. Indigenous Materials: Wood products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- F. Regional Materials: Wood products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- G. Certified Wood: Wood products shall be certified as "FSC Pure" [or **"FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
- H. Certified Wood: Wood products shall be certified as "FSC Pure" [or **"FSC Mixed Credit"**] according to FSC STD-01-001 and FSC STD-40-004.
- I. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
- J. Certified Wood: Wood products shall [**contain not less than 60 percent**] [**be made from**] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by 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."
- K. Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
- L. Product Designations:
 - 1. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."
 - 2. Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 HARDWARE AND ACCESSORIES

- A. Hardware: Unless otherwise indicated, provide manufacturer's standard [**satin-finish**] [**mirror polished-finish**] [**powder-coated**], commercial-quality, heavy-duty hardware.
 - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-

bolted from back side.

- B. Butt Hinges: [Stainless steel] [Chrome-plated] [Powder-coated], semiconcealed, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than **48 inches** high, and provide three hinges for doors more than **48 inches** high.
- C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602[, self-closing]. Provide two hinges for doors less than **48 inches** high, and provide three hinges for doors more than **48 inches** high.
 - 1. Degrees of Opening: [100] [135] [170] degrees.
- D. Wire Pulls: Solid [nylon] [aluminum] [stainless steel] [or] [chrome-plated brass] wire pulls, fastened from back with two screws.
 - 1. For sliding doors, provide recessed [stainless steel] [or] [chrome-plated] flush pulls.
 - 2. Provide two pulls for drawers more than **24 inches** wide.
- E. Semirecessed Pulls: Plastic. For sliding doors, provide recessed plastic flush-pulls. Provide two pulls for drawers more than **24 inches** wide.
- F. Door Catches: [Zinc-plated] [Powder-coated], [nylon-roller spring catch] [or] [dual, self-aligning, permanent magnet catch]. Provide two catches on doors more than **48 inches** high.
- G. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
 - 1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
 - 2. Drawers: Provide one bumper on back side of drawer front at each corner.
- H. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Manufacturer's standard.
 - 2. Standard Duty (Grade 1): [Side mount] [Undermount].
 - 3. Heavy Duty (Grade 1HD-100): [Side mount] [Undermount].
 - a. Type: [Full] [Full overtravel] [Partial] extension.
 - b. Material: [Epoxy-coated polymer] [Zinc-plated steel] slides.
 - c. Motion Feature: [Soft close dampener] [Self-closing mechanism].
 - 4. General-purpose drawers; provide [**100 lb**] <Insert weight> load capacity.
 - 5. File drawers; provide [**150 lb**] <Insert weight> load capacity.
- I. Label Holders: [Stainless steel] [or] [chrome plated], sized to receive standard label cards approximately **1 by 2 inches**, and attached with screws or brads.
 - 1. Provide label holders [where indicated] [on drawers].
- J. Drawer and Hinged-Door Locks: [Cylindrical (cam)] [Mortise] type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.
 - 1. Provide a minimum of two keys per lock and six master keys.
 - 2. Provide locks [where indicated] [on every door and drawer].

- a. Master key for up to [500] <Insert number> key changes.
- K. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.
 - 1. Pin-type, [two-pin-locking plastic shelf rests complying with ANSI/BHMA A156.9, Type B04013] [Single-pin metal shelf rests complying with ANSI/BHMA A156.9, Type B04013].
 - 2. Mortise-type, [zinc-plated] [powder-coated] steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

2.3 MATERIALS

- A. ~~Composite Wood Products: Products shall be made without urea formaldehyde.~~
- B. ~~Composite Wood Products: Products 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."~~
- C. ~~Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.~~
- D. ~~Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:~~
 - 1. ~~Hardwood Plywood: 0.05 ppm.~~
 - 2. ~~Particleboard: 0.09 ppm.~~
 - 3. ~~MDF More Than 5/16 Inch Thick: 0.11 ppm.~~
 - 4. ~~MDF 5/16 Inch or Less in Thickness: 0.13 ppm.~~
- E. ~~Composite Wood Products: Products shall be made without urea formaldehyde.~~
- F. ~~Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.~~
- G. ~~Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.~~
- H. ~~Softwood Plywood: DOC PS 1.~~
- I. ~~Particleboard: ANSI A208.1, Grade M-2.~~
 - 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
- J. ~~MDF: Medium density fiberboard, ANSI A208.2, [Grade 130] <Insert grade>.~~
 - 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
- K. ~~Hardboard: ANSI A135.4, Class 1 tempered.~~

- 1. ~~Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.~~
- L. ~~PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.~~
- M. ~~Thermally Fused Laminate Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper [and complying with requirements of ISO 4586].~~
 - 1. ~~Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.~~
- N. ~~Glass for Glazed Doors:~~
 - 1. ~~Clear float glass complying with ASTM C1036, Type I, Class 1, Quality Q3; not less than [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] thick.~~
 - 2. ~~Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3; not less than 5.0 mm thick.~~
 - 3. ~~Clear laminated annealed glass complying with ASTM C1172, Kind LA, Condition A, Type I, Class I, Quality Q3; with two plies not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.~~
- O. ~~Frameless Glass Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3; not less than [5.0 mm] [6.0 mm] thick; with exposed edges seamed before tempering.~~
- P. ~~Adhesives: Do not use adhesives that contain urea formaldehyde.~~
- Q. ~~Adhesives: Use adhesives that meet 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."~~
- R. ~~Adhesives: Use adhesives that meet 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."~~
- S. ~~Adhesives: Do not use adhesives that contain urea formaldehyde.~~
- T. ~~Adhesives: Do not use adhesives that contain urea formaldehyde.~~

2.42.3 FABRICATION

- A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:
 - 1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: **3/4-inch** particleboard.
 - 2. Shelves: ~~[3/4-inch- thick particleboard]~~ **[3/4-inch- thick plywood or 1-inch- thick particleboard]**.
 - 3. Backs of Casework: **1/2-inch-** thick particleboard or MDF where exposed, ~~[1/4-inch- thick hardboard]~~ **[1/4-inch- thick, veneer-core hardwood plywood]** dadoed into sides, bottoms, and tops where not exposed.
 - 4. Drawer Fronts: **3/4-inch** particleboard.
 - 5. Drawer Sides and Backs: **1/2-inch-** thick **[solid-wood or veneer-core hardwood plywood]** **[particleboard or MDF]**, with glued dovetail or multiple-dowel joints.
 - 6. Drawer Bottoms: **1/4-inch-** thick **[hardwood plywood]** **[particleboard or MDF]** glued and dadoed into front, back, and sides of drawers. **[Use 1/2-inch material for drawers more than 24 inches wide.]**

7. Drawer Bodies: Steel drawer pans formed from **0.0359-inch** thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of **1 mil** for topcoat and **2 mils** for system.
 8. Cabinet Doors:
 - a. 48 Inches (1220 mm) High or Less: **3/4 inch** thick, with particleboard or MDF cores[**and solid-wood stiles and rails**].
 - b. 48 Inches (1220 mm) or More in Height: [**1-1/16 inches thick, with solid hardwood stiles and rails and honeycomb**] [**1-1/8 inches thick, with particleboard**] cores.
 9. Stiles and Rails of Glazed Doors:
 - a. 48 Inches (1220 mm) High or Less: **3/4 inch** thick, with particleboard cores.
 - b. 48 Inches (1220 mm) or More in Height: [**1-1/16 inches thick, with solid wood**] [**1-1/8 inches thick, with particleboard**] cores.
- B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Grade: Install casework to comply with same quality standard grade as item to be installed.
- B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within **1/16 inch** of a single plane. Align similar adjoining doors and drawers to a tolerance of **1/16 inch**. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within **1/16 inch** of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of **1/16 inch**.
- E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

- G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through **[AWI's Quality Certification Program]** **[WI's Certified Compliance Program]** certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
 - 1. Inspection entity to prepare and submit report of inspection.

3.4 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216

SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Plastic-laminate-clad countertops.~~
- ~~2. Fire-retardant-treated materials.~~
- ~~3. Accessories.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Plastic-laminate-clad countertops.
2. Fire-retardant-treated materials.
3. Accessories.

B. Product Data Submittals: For each product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Environmental Product Declaration (EPD): For each product.
4. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
5. Environmental Product Declaration: For each product.
6. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.
11. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
12. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
13. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
14. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
15. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
16. Product Data: For adhesives, indicating that product contains no urea formaldehyde.

17. Product Data: For installation adhesives, indicating VOC content.
18. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
19. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
20. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
21. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
22. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
23. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

D. Shop Drawings: For plastic-laminate-clad countertops.

1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
2. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.
3. Apply [AWI Quality Certification] [WI Certified Compliance] Program label to Shop Drawings.

E. Samples: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.

F. Samples for Initial Selection: For plastic laminates.

G. Samples for Verification: As follows:

1. Plastic Laminates: For each type, color, pattern, and surface finish required, [8 by 10 inches] [12 by 12 inches] in size.
2. Wood-Grain Plastic Laminates: For each type, color, pattern, and surface finish required, [12 by 24 inches] [24 by 24 inches] in size.
3. Fabrication Sample: For each type and profile of countertop required, provide one sample applied to core material with specified edge material applied to one edge.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [Installer] [fabricator].

B. Product Certificates: For the following:

1. Composite wood products.
2. High-pressure decorative laminate.
3. Chemical-resistant, high-pressure decorative laminate.
4. Adhesives.

C. Quality Standard Compliance Certificates: [AWI Quality Certification Program] [WI Certified Compliance Program].

D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

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. Shop Certification: [AWI's Quality Certification Program accredited participant] [WI's Certified Compliance Program licensee].

- B. Installer Qualifications: **[Fabricator of products] [AWI's Quality Certification Program accredited participant] [WI's Certified Compliance Program licensee]**.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.6 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install 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 countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between **60 and 90 deg F** and relative humidity between **[25 and 55] [43 and 70] [20 and 50] <Insert numbers>** percent during the remainder of the construction period.
- C. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 FABRICATORS

- A. Fabricators: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. **<Insert, in separate subparagraphs, names and contact information for preapproved woodworking firms>.**

~~2.2 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.~~
- ~~1. Provide inspections of fabrication and installation together with labels and certificates from [AWI] [WI] certification program indicating that countertops comply with requirements of grades specified.~~

2. — The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. — Grade: ~~[Premium]~~ ~~[Custom]~~ ~~[Economy]~~.
- C. — Regional Materials: Wood products shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site.
- D. — Regional Materials: Wood products shall be manufactured within ~~500 miles~~ of Project site.
- E. — Regional Materials: Wood products shall be manufactured within ~~100 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~100 miles~~ of Project site.
- F. — Indigenous Materials: Wood products shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- G. — Regional Materials: Wood products shall be manufactured within ~~500 miles~~ of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within ~~500 miles~~ of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
- H. — Certified Wood: Wood products shall be certified as "FSC Pure" ~~[or "FSC Mixed Credit"]~~ according to FSC STD-01-001 and FSC STD-40-004.
- I. — Certified Wood: Wood products shall be certified as "FSC Pure" ~~[or "FSC Mixed Credit"]~~ according to FSC STD-01-001 and FSC STD-40-004.
- J. — Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.
- K. — Certified Wood: Wood products shall ~~[contain not less than 60 percent]~~ ~~[be made from]~~ certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by 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."
- L. — Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
- M. — 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. — Solid colors, ~~[gloss]~~ ~~[matte]~~ finish.
 - b. — Solid colors with core same color as surface, ~~[gloss]~~ ~~[matte]~~ finish.
 - c. — Wood grains, ~~[gloss]~~ ~~[matte]~~ finish with grain running parallel to length of countertop.

- d. ~~Patterns, [gloss] [matte] finish.~~
- N. ~~Edge Treatment: [Same as laminate cladding on horizontal surfaces] [2.0-mm PVC edging] [3.0-mm PVC edging] [Lumber edge for transparent finish matching wood species and cut on cabinet surfaces] [As indicated on Drawings].~~
- O. ~~Core Material: [Particleboard or MDF] [Particleboard] [MDF] [Particleboard made with exterior glue] [MDF made with exterior glue] [Exterior-grade plywood] [Fire-retardant-treated plywood] [Fire-retardant particleboard] [Fire-retardant MDF] [As selected by fabricator to comply with quality standard].~~
- P. ~~Core Material at Sinks: [Particleboard made with exterior glue] [MDF made with exterior glue] [or] [exterior-grade plywood] <Insert requirements>.~~
- Q. ~~Core Thickness: [3/4 inch] [1-1/8 inch].~~
- T. ~~Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.~~
- R. ~~Backer Sheet: Provide plastic-laminate backer sheet, ISO 4586-3, grade to match exposed surface, on underside of countertop substrate.~~
- S. ~~Paper Backing: Provide paper backing on underside of countertop substrate.~~

2.32.2 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] [8 to 13] [4 to 9] 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: Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products 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."
3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
4. Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D6007 or ASTM E1333:
- a. Hardwood Plywood: 0.05 ppm.
- b. Particleboard: 0.09 ppm.
- c. MDF More Than 5/16 Inch Thick: 0.11 ppm.
- d. MDF 5/16 Inch or Less in Thickness: 0.13 ppm.
5. Composite Wood Products: Products shall be made without urea formaldehyde.
6. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.

7. MDF: Medium-density fiberboard, ANSI A208.2, [Grade 130] <Insert grade>.
8. Particleboard: ANSI A208.1, [Grade M-2] [Grade M-2-Exterior Glue].
9. Softwood Plywood: DOC PS 1.

2.4 ~~FIRE-RETARDANT-TREATED MATERIALS~~

- A. ~~Fire Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.~~
- ~~1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.~~
 - ~~2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.~~
 - ~~3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.~~
- B. ~~Fire Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, 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 beyond the centerline of the burners at any time during the test.~~
- ~~1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.~~
 - ~~2. For items indicated to receive a stained or natural transparent finish, use organic resin chemical formulation.~~
 - ~~3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.~~
 - ~~4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of exposed treated woodwork.~~

2.5 ~~ACCESSORIES~~

- A. ~~Paper Slots: [12 inches] [17 inches] long by 1-3/4 inches wide by 1 inch deep; molded plastic, paper-slot liner with 1/4-inch lip.~~
- ~~1. Color: [Brown] [Black] <Insert color>.~~

2.62.3 MISCELLANEOUS MATERIALS

- A. Adhesives: Do not use adhesives that contain urea formaldehyde.
- B. Adhesives: Use adhesives that meet 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."
- C. Adhesives: Use adhesives that meet 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."
- D. Adhesives: Do not use adhesives that contain urea formaldehyde.

- E. Adhesives: Do not use adhesives that contain urea formaldehyde.
- F. Adhesive for Bonding Plastic Laminate: **[Type I, waterproof type]** **[Type II water-resistant type]** as selected by fabricator to comply with requirements.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive **[or adhesive specified above for faces]**.
- G. Installation Adhesive:
 - 1. Adhesives shall have a VOC content of **[70]** **<Insert value>** g/L or less.
 - 2. Adhesive 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."
 - 3. Adhesive 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."
 - 4. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - 5. Adhesive 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."
 - 6. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

2.72.4 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of **1 inch** over base cabinets. Ease edges to radius indicated for the following:
 - 1. Solid-Wood (Lumber) Members: **1/16 inch** unless otherwise indicated.
- C. 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.
 - 1. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.
- D. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 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** of front and back edges and at intervals not exceeding **24 inches**. 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. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. 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** variation from a straight, level plane.
 2. Secure backsplashes **[to tops with concealed metal brackets at 16 inches o.c.] [and] [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.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.
- B. Clean countertops on exposed and semiexposed surfaces.
- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of **48 inches** o.c. Remove protection at Substantial Completion.

END OF SECTION 123623.13

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Quartz agglomerate countertops.
2. Quartz agglomerate backsplashes.
3. Quartz agglomerate end splashes.
4. Quartz agglomerate apron fronts.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
7. Product Data: For composite wood products, indicating compliance with requirements for formaldehyde emissions.
8. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:

1. Countertop material, **6 inches** square.
2. Wood trim, **8 inches** long.
3. One full-size quartz agglomerate countertop, with front edge [**and backsplash**], **8 by 10 inches**, of construction and in configuration specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as indicated on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements [**after base cabinets are installed but**] before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

~~2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS~~

- ~~A. Solid Wood Edges and Trim: Clear [red oak] [white oak] [hard maple] [cherry] <Insert species> lumber, free of defects, selected for compatible grain and color, and kiln dried to 7 percent moisture content.
 - ~~1. Certified Wood: Wood products shall be certified as "FSC Pure" [or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.~~
 - ~~2. Certified Wood: Wood products shall be certified as "FSC Pure" [or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.~~
 - ~~3. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the~~~~

Programme for Endorsement of Forest Certification.

4. ~~Certified Wood: Wood products shall [contain not less than 60 percent] [be made from] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by 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."~~
5. ~~Certified Wood: Wood products shall be certified according to the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC-STD-01-001 and FSC-STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.~~
- B. ~~Composite Wood Products: Products shall be made without urea formaldehyde.~~
- C. ~~Composite Wood Products: Products 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."~~
- D. ~~Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.~~
- E. ~~Composite Wood Products: Formaldehyde emission rates shall not be greater than the following when tested according to ASTM D 6007 or ASTM E 1333:~~
 1. ~~Hardwood Plywood: 0.05 ppm.~~
 2. ~~Particleboard: 0.09 ppm.~~
 3. ~~MDF More Than 5/16 Inch Thick: 0.11 ppm.~~
 4. ~~MDF 5/16 Inch or Less in Thickness: 0.13 ppm.~~
- F. ~~Composite Wood Products: Products shall be made without urea formaldehyde.~~
- G. ~~Particleboard: ANSI A208.1, [Grade M-2] [Grade M-2 Exterior Glue].~~
- H. ~~Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.~~

2.22.1 FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 1. Grade: [Premium] [Custom] [Economy].
- B. Configuration:
 1. Front: [Straight, slightly eased at top] [Beveled] [3/4-inch bullnose] [Radius edge with apron, 2 inches high with 3/8-inch radius] [1-1/2-inch laminated bullnose] [1-inch laminated bullnose] [Straight, slightly eased at top with separate apron, 6 inches high, recessed 1/4-inch behind front edge] [Wood-trimmed edge as indicated].
 2. Backsplash: [Straight, slightly eased at corner] [Beveled] [Radius edge with 3/8-inch radius].
 3. End Splash: [Matching backsplash] [None].
- C. Countertops: [1/2-inch] [3/4-inch] thick, quartz agglomerate [with wood-trimmed edges] [with front edge built up with same

material].

- D. Backsplashes: [~~1/2-inch~~] [~~3/4-inch~~] thick, quartz agglomerate [~~with wood-trimmed edges~~].
- E. Fabricate tops with shop-applied edges [~~and backsplashes~~] unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints:
 - 1. Fabricate countertops without joints.
 - 2. Fabricate countertops in sections for joining in field [~~, with joints at locations indicated~~].
 - a. Joint Locations: Not within **18 inches** of a sink or cooktop and not where a countertop section less than **36 inches** long would result, unless unavoidable.
 - b. Joint Type, Bonded: **1/32 inch** or less in width.
 - c. Joint Type, Grouted: **1/16 inch** in width.
 - d. Joint Type, Sealant Filled: **1/16 inch** in width.
 - e. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints [~~where indicated~~]. Make width of cuts slightly more than thickness of splines to provide snug fit. [**Provide at least three splines in each joint.**]
- G. 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.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting **3/16 inch** into fixture opening.
 - b. Provide vertical edges, rounded to **3/8-inch** radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting **3/16 inch** into fixture opening.
 - c. Provide **3/4-inch** full bullnose edges projecting **3/8 inch** into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.32.2 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.
 - 1. Adhesives shall have a VOC content of [**70**] ~~<Insert value>~~ g/L or less.
 - 2. Adhesive 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."
 - 3. Adhesive 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."

4. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive 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."
6. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of **1/8 inch in 8 feet, 1/4 inch** maximum. Do not exceed **1/64-inch** difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 1. Install metal splines in kerfs in countertop edges at joints[**where indicated**]. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of

specified width.

- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. 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.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.19

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Copper tube and fittings - domestic water.~~
- ~~2. Ductile-iron pipe and fittings - domestic water.~~
- ~~3. Galvanized-steel pipe and fittings - domestic water.~~
- ~~4. Stainless steel piping and fittings - domestic water.~~
- ~~5. CPVC piping - domestic water.~~
- ~~6. PEX tube and fittings - domestic water.~~
- ~~7. PEX-AL-PEX tube and fittings - domestic water.~~
- ~~8. PEX-AL-HDPE tube and fittings - domestic water.~~
- ~~9. PVC pipe and fittings - domestic water.~~
- ~~10. Polypropylene (PP-R and PP-RCT) pipe and fittings - domestic water.~~
- ~~11.1. Piping joining materials - domestic water.~~
- ~~12.2. Encasement for piping.~~
- ~~13. Transition fittings - domestic water.~~
- ~~14. Dielectric fittings - domestic water.~~

B. ~~Related Requirements:~~

- ~~1. Section 331415 "Site Water Distribution Piping" for water-service piping [and water meters] outside the building from source to the point where water-service piping enters the building.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper tube and fittings - domestic water.
2. Ductile-iron pipe and fittings - domestic water.
3. Galvanized-steel pipe and fittings - domestic water.
4. Stainless steel piping and fittings - domestic water.
5. CPVC piping - domestic water.
6. PEX tube and fittings - domestic water.
7. PEX-AL-PEX tube and fittings - domestic water.
8. PEX-AL-HDPE tube and fittings - domestic water.
9. PVC pipe and fittings - domestic water.
10. Polypropylene (PP-R and PP-RCT) pipe and fittings - domestic water.
11. Piping joining materials - domestic water.
12. Encasement for piping.
13. Transition fittings - domestic water.

14. Dielectric fittings - domestic water.

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. Environmental Product Declaration: For each product.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Environmental Product Declaration: For each product.
9. Third-Party Certifications: For each product.
10. Third-Party Certified Life Cycle Assessment: For each product.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.5 FIELD 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 in accordance with requirements indicated:
 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of water service.
 2. Do not interrupt water service without [Architect's] [Construction Manager's] [Owner's] written permission.

1.6 WARRANTY

- A. Polypropylene (PP-R and PP-RCT) Pipe and Fittings Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of piping system due to defects in materials or manufacturing.
 2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation

indicating that the system was tested and passed manufacturer's pressure/leak test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

- A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. [Include marking "NSF-pw" on piping.]

~~2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER~~

- ~~A. Drawn-Temper Copper Tube: [ASTM B88, Type K] [ASTM B88, Type L] [and] [ASTM B88, Type M].~~
- ~~B. Annealed-Temper Copper Tube: [ASTM B88, Type K] [ASTM B88, Type L] [and] [ASTM B88, Type M].~~
- ~~C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.~~
- ~~D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.~~
- ~~E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.~~
- ~~F. Cast 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. Do not use solder joints on pipe sizes greater than NPS 4.~~
- ~~G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.~~

~~2.4 DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER~~

- ~~A. Mechanical-Joint, Ductile-Iron Pipe:
 - ~~1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.~~
 - ~~2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.~~~~
- ~~B. Standard-Pattern, Mechanical-Joint Fittings:
 - ~~1. AWWA C110/A21.10, ductile or gray iron.~~
 - ~~2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.~~~~
- ~~C. Compact-Pattern, Mechanical-Joint Fittings:~~

1. — AWWA C153/A21.53, ductile iron.
2. — Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile or gray iron glands, rubber gaskets, and steel bolts.

D. — Push-on Joint, Ductile-Iron Pipe:

1. — AWWA C151/A21.51.
2. — Push-on joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. — Standard-Pattern, Push-on Joint Fittings:

1. — AWWA C110/A21.10, ductile or gray iron.
2. — Gaskets: AWWA C111/A21.11, rubber.

F. — Compact-Pattern, Push-on Joint Fittings:

1. — AWWA C153/A21.53, ductile iron.
2. — Gaskets: AWWA C111/A21.11, rubber.

G. — Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

2.5 — GALVANIZED STEEL PIPE AND FITTINGS - DOMESTIC WATER

A. — Galvanized Steel Pipe:

1. — ASTM A53/A53M, [Type E] <Insert type>, [Grade B] <Insert grade>, Standard Weight.
2. — Include ends matching joining method.

B. — Galvanized Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless steel pipe with threaded ends.

C. — Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. — Malleable-Iron Unions:

1. — ASME B16.39, Class 150.
2. — Hexagonal stock body.
3. — Ball and socket, metal-to-metal, bronze seating surface.
4. — Threaded ends.

E. — Flanges: ASME B16.1, Class 125, cast iron.

2.6 — STAINLESS STEEL PIPING AND FITTINGS - DOMESTIC WATER

A. — Potable-water piping and components are to comply with NSF 61 and NSF 372.

B. — Stainless Steel Pipe: ASTM A312/A312M, seamless, stainless steel of types and schedules as indicated in "Piping Applications" Article.

~~C. — Stainless Steel Pipe Fittings: ASTM A815/A815M.~~

~~2.7 — PEX TUBE AND FITTINGS - DOMESTIC WATER~~

~~A. — Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.~~

~~2.8 — PVC PIPE AND FITTINGS - DOMESTIC WATER~~

~~A. — PVC Socket Fittings: [ASTM D2466 for Schedule 40] [and] [ASTM D2467 for Schedule 80].~~

~~B. — PVC Schedule 80 Threaded Fittings: ASTM D2464.~~

2.92.3 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, **1/8 inch** thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

1. Solvent cement shall have a VOC content of 490 g/L or less.
2. Adhesive 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."
3. Adhesive 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."
4. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive 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."
6. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or

33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

- G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.
1. Solvent cement shall have a VOC content of 510 g/L or less.
 2. Adhesive primer shall have a VOC content of 550 g/L or less.
 3. Adhesive 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."
 4. Adhesive 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."
 5. Adhesive 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 6. Adhesive 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."
 7. Adhesive 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
 8. Adhesive primer 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."
 9. Adhesive primer 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."
 10. Adhesive primer 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 11. Adhesive primer 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.102.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: [Sheet] [or] [tube].
- C. Color: [Black] [or] [natural] <Insert color>.

2.11 — ~~TRANSITION FITTINGS - DOMESTIC WATER~~

A. — ~~General Requirements:~~

- ~~1. — Same size as pipes to be joined.~~
- ~~2. — Pressure rating at least equal to pipes to be joined.~~
- ~~3. — End connections compatible with pipes to be joined.~~

B. — ~~Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.~~

2.12 — ~~DIELECTRIC FITTINGS - DOMESTIC WATER~~

A. — ~~General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.~~

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller is to be the following:
 1. Annealed-temper copper tube, **[ASTM B88, Type K]** **[ASTM B88, Type L]**; ~~[wrought-copper, solder-joint fittings; and brazed]~~ **[copper pressure-seal fittings; and pressure-sealed]** joints.
 2. PVC, **[Schedule 40]** **[Schedule 80]**; socket fittings; and solvent-cemented joints.
 3. Polypropylene (PP-R and PP-RCT), **[SDR 7.4]** **[SDR 11]** pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger is to be the following:
 1. Annealed-temper copper tube, **[ASTM B88, Type K]** **[ASTM B88, Type L]**; wrought-copper, solder-joint fittings; and brazed joints.
 2. Mechanical-joint, ductile-iron pipe; ~~[standard-]~~ **[or]** **[compact-]** pattern, mechanical-joint fittings; and mechanical joints.
 3. Push-on joint, ductile-iron pipe; ~~[standard-]~~ **[or]** **[compact-]** pattern, push-on joint fittings; and gasketed joints.
 4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 5. PVC, **[Schedule 40]** **[Schedule 80]**; socket fittings; and solvent-cemented joints.
 6. Polypropylene (PP-R and PP-RCT), **[SDR 7.4]** **[SDR 11]** pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) is to be the following:

1. Mechanical-joint, ductile-iron pipe; ~~[standard-]~~ **[or] [compact-]** pattern, mechanical-joint fittings; and mechanical joints.
 2. Push-on joint, ductile-iron pipe; ~~[standard-]~~ **[or] [compact-]** pattern, push-on joint fittings; and gasketed joints.
 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller is to be the following:
1. ~~[Drawn-temper]~~ **[or] [annealed-temper]** copper tube, **ASTM B88, Type L**; ~~[wrought-copper, solder-joint fittings; and brazed]~~ **[copper pressure-seal-joint fittings; and pressure-sealed]** joints.
 2. PVC, **[Schedule 40] [Schedule 80]**; socket fittings; and solvent-cemented joints.
 3. Polypropylene (PP-R and PP-RCT), **[SDR 7.4] [SDR 11]** pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller is to be the following:
1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; ~~[cast-]~~ **[or] [wrought-]** copper, solder-joint fittings; and ~~[brazed]~~ **[soldered]** joints.
 3. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; copper pressure-seal-joint fittings; and pressure-sealed joints.
 4. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; copper push-on joint fittings; and push-on joints.
 5. Stainless steel, **[Schedule 5] [or] [Schedule 10]** pipe; pressure-seal-joint fittings; and pressure-sealed joints.
 6. CPVC, **[Schedule 40] [Schedule 80]**; socket fittings; and solvent-cemented joints.
 7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 8. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. **[NPS 1-1/2 and NPS 2 CPVC pipe with CPVC socket fittings may be used instead of tubing.]**
 9. PEX tube, **NPS 1** and smaller.
 - a. Fittings for PEX tube:
 - 1) ASTM F1807, metal insert and copper crimp rings.
 - 2) ASTM F1960, cold expansion fittings and reinforcing rings.
 - 3) ASSE 1061, push-fit fittings.
 10. PEX-AL-PEX tube, **NPS 1** and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
 11. PVC, **[Schedule 40] [Schedule 80]**; socket fittings; and solvent-cemented joints.
 12. Polypropylene (PP-R and PP-RCT), **[SDR 7.4] [SDR 11]** pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) is to be the following:
1. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; ~~[cast-]~~ **[or] [wrought-]** copper, solder-joint fittings; and ~~[brazed]~~ **[soldered]** joints.
 2. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Drawn-temper copper tube, **[ASTM B88, Type L] [ASTM B88, Type M]**; grooved-joint, copper-tube appurtenances; and grooved joints.
 4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 6. Stainless steel, **[Schedule 5] [Schedule 10] [Schedule 40]** pipe; grooved-joint fittings, and grooved joints.

7. CPVC, [Schedule 40] [Schedule 80]; socket fittings; and solvent-cemented joints.
8. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
9. PVC, [Schedule 40] [Schedule 80]; socket fittings; and solvent-cemented joints.
10. Polypropylene (PP-R and PP-RCT), [SDR 7.4] [SDR 11] pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), is to be the following:

1. Drawn-temper copper tube, [ASTM B88, Type L] [ASTM B88, Type M]; [~~cast~~] [~~or~~] [~~wrought~~] copper, solder-joint fittings; and [~~brazed~~] [~~soldered~~] joints.
2. Drawn-temper copper tube, [ASTM B88, Type L] [ASTM B88, Type M]; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
5. Stainless steel [Schedule 5] [Schedule 10] [Schedule 40] pipe, grooved-joint fittings, and grooved joints.
6. CPVC, [Schedule 40] [Schedule 80]; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, [Schedule 40] [Schedule 80]; socket fittings; and solvent-cemented joints.
9. Polypropylene (PP-R and PP-RCT) [SDR 7.4] [SDR 11] pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) is to be the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Stainless steel [Schedule 5] [Schedule 10] [Schedule 40] pipe, grooved-joint fittings, and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

- 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 in accordance with CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.
- D. Install underground [~~copper tube~~] [~~and~~] [~~ductile-iron pipe~~] in PE encasement in accordance with ASTM A674 or AWWA C105/A21.5.
- E. Install valves in accordance with the following:
 1. Section 220523.12 "Ball Valves for Plumbing Piping."

2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
 3. Section 220523.14 "Check Valves for Plumbing Piping."
 4. Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level [**with 0.25 percent slope downward toward drain**] [**without pitch**] and plumb.
- H. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. 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.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install PEX tube with loop at each change of direction of more than 90 degrees.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."
- T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."
- U. Install thermometers on[**inlet and**] outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 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 in accordance with 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. **[Square cut]** **[Roll]** groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. 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 in accordance with ASME B31.9.
- M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.

3. PVC Piping: Join in accordance with ASTM D2855.

- N. Joints for PEX Tubing, ASTM: Join in accordance with ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
- O. Joints for PEX Tubing, ASSE: Join in accordance with ASSE 1061 for push-fit fittings.
- P. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition [fittings] [or] [unions].

3.6 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [couplings] [couplings or nipples] [nipples] [unions].
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [flanges] [flange kits] [nipples].
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for [copper] [ductile iron] [galvanized steel] [and] [stainless steel] [tube] [and] [pipe], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install vinyl-coated hangers for [CPVC] [PVC] [and] [PP-R/PP-RCT] pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- E. Install vinyl-coated hangers for PEX tube, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support horizontal piping within [12 inches] <Insert dimension> of each fitting.
- G. Support vertical runs of [copper] [ductile iron] [galvanized steel] [and] [stainless steel] [tube] [and] [pipe] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- H. Support vertical runs of [CPVC] [PVC] [and] [PP-R/PP-RCT] pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- I. Support vertical runs of PEX tube to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for 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 that required by plumbing code.
 - 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.

3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 CLEANING

- A. Clean and disinfect 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 in accordance with 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. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- 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. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 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 hot-water flow 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.

3.12 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. 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:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. 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.
 - c. 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.
 - d. Cap and subject piping to static water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
 - f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - g. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Hub-and-spigot, cast-iron soil pipe and fittings.~~
- ~~2. Hubless, cast-iron soil pipe and fittings.~~
- ~~3. Galvanized steel pipe and fittings.~~
- ~~4. Stainless steel drainage pipe and fittings.~~
- ~~5. Ductile-iron pipe and fittings.~~
- ~~6. Copper tube and fittings.~~
- ~~7. ABS pipe and fittings.~~
- ~~8. PVC pipe and fittings.~~
- ~~9.1. Specialty pipe fittings.~~
- ~~10.2. Encasement for underground metal piping.~~

B. Related Requirements:

- ~~1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.~~
- ~~2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.~~
- ~~3. Section 226600 "Chemical Waste Systems for Laboratory and Healthcare Facilities" for chemical waste and vent piping systems.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized steel pipe and fittings.
4. Stainless steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. ABS pipe and fittings.
8. PVC pipe and fittings.
9. Specialty pipe fittings.
10. Encasement for underground metal piping.

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 hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.
- B. 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.
- C. Field quality-control reports.

1.4 FIELD 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 in accordance with requirements indicated:
 - 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without [Architect's] [Construction Manager's] [Owner's] written permission.

1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: [10 ft. head of water] <Insert pressure>.
 - 2. Waste, Force-Main Piping: [50 psig] [100 psig] [150 psig] <Insert pressure>.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7] <Insert requirement>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":
 - 1. 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. Component Importance Factor: [1.5] [1.0].

- C. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 ~~SPECIALTY PIPE FITTINGS~~

A. ~~Transition Couplings:~~

- ~~1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.~~
- ~~2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.~~

B. ~~Dielectric Fittings:~~

- ~~1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.~~

2.4.2.3 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A674 or AWWA C105/A 21.5.
- B. Material: [Linear low-density polyethylene film of 0.008-inch] [or] [high-density, cross-laminated polyethylene film of 0.004-inch] minimum thickness.
- C. Form: [Sheet] [or] [tube].
- D. Color: [Black] [or] [natural] <Insert color>.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other

- design considerations.
2. 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 [Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"] [Section 220548.13 "Vibration 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.
1. 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.
 2. 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.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: Two percent downward in direction of flow for piping **NPS 3** and smaller; [1] [2] <Insert number> percent downward in direction of flow for piping **NPS 4** and larger.
 2. Horizontal Sanitary Waste Piping: [Two] <Insert number> percent downward in direction of flow.
 3. Vent Piping: [One] <Insert number> percent down toward vertical fixture vent or toward vent stack.

- N. Install cast-iron soil piping in accordance with 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 in accordance with ASTM A674 or AWWA C105/A 21.5.
- O. Install steel piping in accordance with applicable plumbing code.
- P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.
- Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."
- R. Install aboveground ABS piping in accordance with ASTM D2661.
- S. Install aboveground PVC piping in accordance with ASTM D2665.
- T. Install underground [ABS] [and] [PVC] piping in accordance with ASTM D2321.
- U. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- V. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- X. Install force mains at elevations indicated.
- Y. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waste gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary waste gravity-flow piping.

- a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 - Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - AA. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
 - BB. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
 - CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."
- 3.3 JOINT CONSTRUCTION
- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
 - C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with 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 in accordance with ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
 - E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.
 - F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
 - G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
 - H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

- I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
 - 3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- J. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings **[5 inches]** **<Insert dimensions>** and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings **[4 inches]** **<Insert dimensions>** and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings **[5 inches]** **<Insert dimensions>** and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: **[Unshielded]** **[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 (DN 40) and Smaller: Fitting-type transition couplings.
 - b. NPS 2 (DN 50) and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric **[nipples]** **[unions]**.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric **[flanges]** **[flange kits]** **[nipples]**.
 - 4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

- A. General valve installation requirements for general-duty valve installation are specified in the following Sections:
 - 1. Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
 - 3. Section 220523.14 "Check Valves for Plumbing Piping."
 - 4. Section 220523.15 "Gate Valves for Plumbing Piping."
- B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
 2. Install [gate] [full-port ball] valve for piping **NPS 2** and smaller.
 3. Install [gate] <Insert type> 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. [**Use normally closed type unless otherwise indicated.**]
 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 Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in [Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"] [Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"].
1. Install [carbon-steel] <Insert material> pipe hangers for horizontal piping in noncorrosive environments.
 2. Install [stainless steel] [fiberglass] pipe hangers for horizontal piping in corrosive environments.
 3. Install [carbon-steel] <Insert material> 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 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52 spring hangers.
- C. Install hangers for [cast-iron] [steel] [stainless steel] [and] [copper] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for [ABS] [and] [PVC] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within **12 inches** of each fitting[, valve,] and coupling.
- F. Support vertical runs of [cast-iron] [steel] [stainless steel] [and] [copper] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of [ABS] [and] [PVC] piping to comply with manufacturer's written instructions, locally enforced codes, and

authorities having jurisdiction requirements, whichever are most stringent.

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 waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste 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 waste 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. Install horizontal backwater valves [with cleanout cover flush with floor] [in pit with pit cover flush with floor] <Insert description>.
 - 6. Comply with requirements for [backwater valves] [cleanouts] [and] [drains] specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections **NPS 2-1/2** and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
 - 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections in accordance with 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.
- B. Comply with requirements for identification specified in Section 220553 "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 waste and vent piping in accordance with 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.
 - a. 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 waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than **10 ft. head of water**.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. 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.
 - a. 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**.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of **50 psig** above operating pressure, without exceeding pressure rating of

pipng system materials.

- a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping 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 Plastic Piping: Protect **[ABS]** **[PVC]** plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:
 1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings **[and hubless, single-stack aerator fittings];** **[CISPI]** **[heavy-duty]** hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
 5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 6. **[Solid-wall]** **[Cellular-core]** ABS pipe, ABS socket fittings, and solvent-cemented joints.
 7. **[Solid-wall]** **[Cellular-core]** PVC pipe, PVC socket fittings, and solvent-cemented joints.
 8. Dissimilar Pipe-Material Couplings: **[Unshielded]** **[Shielded]**, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
 1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings **[and hubless, single-stack aerator fittings];** **[CISPI]** **[heavy-duty]** hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
 5. **[Solid-wall]** **[Cellular-core]** PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: **[Unshielded]** **[Shielded]**, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Stainless steel pipe and fittings gaskets, and gasketed joints.
 5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, **Type M**; copper pressure fittings; and soldered joints.
 6. [Solid-wall] [Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
 7. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 8. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:
1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:
1. [Extra-heavy] [Service] cast-iron soil piping; [gaskets; and gasketed] [caulking materials; and caulked] joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] [cast-iron] hubless-piping couplings; and coupled joints.
 3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
 4. [Solid-wall] [Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
 5. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
1. [Extra-heavy] [Service], cast-iron soil piping; [gaskets; and gasketed] [caulking materials; and caulked] joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] [cast-iron] hubless-piping couplings; coupled joints.
 3. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:
1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:
1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. [~~Hard~~] [~~Soft~~] copper tube, **Type L**; [~~wrought~~] copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than **NPS 1-1/2** and pressure transition coupling for **NPS 1-1/2** and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, **Type L**; [~~wrought~~] copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221414 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Hub-and-spigot, cast-iron soil pipe and fittings.~~
- ~~2. Hubless, cast-iron soil pipe and fittings.~~
- ~~3. Galvanized-steel pipe and fittings.~~
- ~~4. Copper tube and fittings.~~
- ~~5. ABS pipe and fittings.~~
- ~~6. PVC pipe and fittings.~~
- ~~7.1. Specialty pipe fittings.~~
- ~~8.2. Encasement for underground metal piping.~~

~~**B. Related Requirements:**~~

- ~~1. Section 221429 "Sump Pumps" for storm drainage pumps.~~
- ~~2. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. ABS pipe and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.

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 controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:** Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

- B. Seismic Qualification Certificates: For storm drainage 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 certificate is based and their installation requirements.
- C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage 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 **[Architect]** **[Construction Manager]** **[Owner]** no fewer than **[two]** **<Insert number>** days in advance of proposed interruption of storm drainage service.
 - 2. Do not proceed with interruption of storm drainage service without **[Architect's]** **[Construction Manager's]** **[Owner's]** written permission.

1.6 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: **[10-foot head of water]** **<Insert pressure>**.
 - 2. Storm Drainage, Force-Main Piping: **[50 psig]** **[100 psig]** **[150 psig]** **<Insert pressure>**.
- B. Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with **[ASCE/SEI 7]** **<Insert requirement>**. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 1. 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 functional after the seismic event]**."
 - 2. Component Importance Factor: **[1.5]** **[1.0]**.
 - 3. **<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 ~~GALVANIZED STEEL PIPE AND FITTINGS~~

- A. ~~Cast-Iron Drainage Fittings: [Galvanized,]ASME B16.12, threaded.~~
- B. ~~Steel-Pipe Pressure Fittings:~~
 - 1. ~~Steel Pipe Nipples: [Galvanized,]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.~~
 - 2. ~~Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.~~
 - 3. ~~Gray-Iron, Threaded Fittings: [Galvanized,]ASME B16.4, Class 125, standard pattern.~~
- C. ~~Cast-Iron Flanges: ASME B16.1, Class 125.~~
 - 1. ~~Flange Gasket Materials: ASME B16.21, full face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.~~
 - 2. ~~Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.~~

2.4 ~~COPPER TUBE AND FITTINGS~~

- A. ~~Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.~~

2.5 ~~ABS PIPE AND FITTINGS~~

- A. ~~Solvent Cement: ASTM D2235.~~
 - 1. ~~Solvent cement 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. ~~Solvent cement 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."~~
 - 3. ~~Solvent cement 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.~~
 - 4. ~~Solvent cement 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.~~

2.6 PVC PIPE AND FITTINGS

A. Adhesive Primer: ASTM F656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer 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."
3. Adhesive primer 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."
4. Adhesive primer 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
5. Adhesive primer 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

B. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping-system fitting.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.82.3 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A674 or AWWA C105/A 21.5.
- B. Material: [High-density, crosslaminated polyethylene film of 0.004-inch] [or] [linear low-density polyethylene film of 0.008-inch] minimum thickness.
- C. Form: [Sheet] [or] [tube].
- D. Color: [Black] [or] [natural] <Insert color>.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
- B. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- C. Install piping in concealed locations.
 - 1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.
- 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.
- 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. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- M. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.

- N. Install piping at the following minimum slopes unless otherwise indicated.
 - 1. Building Storm Drain: [1/4 inch per foot] <Insert number> downward in direction of flow for piping **NPS 3** and smaller; [1/8 inch per foot] [1/4 inch per foot] <Insert number> downward in direction of flow for piping **NPS 4** and larger.
 - 2. Horizontal Storm Drainage Piping: [1/4 inch per foot] <Insert number> downward in direction of flow.
- O. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- P. Install steel piping in accordance with applicable plumbing code.
- Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."
- R. Install aboveground ABS piping in accordance with ASTM D2661.
- S. Install aboveground PVC piping in accordance with ASTM D2665.
- T. Install underground [ABS] [and] [PVC] piping in accordance with ASTM D2321.
- U. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.
 - 1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- V. Install force mains at elevations indicated.
- W. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
 - 2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 - 3. Install drains in storm drainage gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Y. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
- Z. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with 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 in accordance with ASME B1.20.1.
 1. Cut threads full and clean using sharp dies.
 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- F. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
 3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.
- I. Joint Restraints and Sway Bracing:
 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings **[5 inches]** <Insert dimensions> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings **[4 inches]** <Insert dimensions> and larger, upstream and

- c. downstream of all changes in direction 45 degrees and greater.
Provide rigid sway bracing for pipe and fittings [5 inches] <Insert dimensions> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: [Unshielded] [Shielded], nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [nipples] [unions].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [flanges] [flange kits] [nipples].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES.

A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install [gate] [full port ball valve] for piping **NS 2** and smaller.
3. Install [gate] [butterfly] <Insert type> 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. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install [**carbon-steel**] <Insert material> pipe hangers for horizontal piping in noncorrosive environments.
 2. Install [**stainless steel**] [**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
 3. Install [**carbon-steel**] <Insert material> 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for [**cast-iron**] [**galvanized-steel**] [**and**] [**copper**] soil [**tubing**] [**and**] [**piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for [**ABS**] [**and**] [**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within **12 inches** of each fitting[, **valve**,] and coupling.
- F. Support vertical [**cast-iron**] [**galvanized steel**] [**and**] [**copper**] [**tubing**] [**and**] [**piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.
- G. Support vertical [**ABS**] [**and**] [**PVC**] piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

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.
1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 2. Install horizontal backwater valves [**with cleanout cover flush with floor**] [**in pit with pit cover flush with floor**] <Insert description>.
 3. Comply with requirements for [**backwater valves**] [**cleanouts**] [**and**] [**drains**] specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

- E. Make connections in accordance with 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 storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "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.
 - 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 in accordance with 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.
 - a. 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.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure:
 - a. Test storm drainage piping[, **except outside leaders,**] on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**.
 - c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
 - d. 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.

- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.

3.11 PROTECTION

- A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day and when work stops.
- C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping [**NPS 6 and smaller**] <Insert pipe size range> is to be [**any of**] the following:
1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; [**CISPI**], [**heavy-duty**], hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 5. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
 6. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 7. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.
- C. Aboveground, storm drainage piping [**NPS 8 and larger**] <Insert pipe size range> is to be [**any of**] the following:
1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; [**CISPI**], [**heavy-duty**], hubless-piping couplings; and coupled joints.

3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 5. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- D. Underground storm drainage piping [NPS 6 and smaller] <Insert pipe size range> shall be [any of] the following:
1. [Extra heavy] [Service weight], cast-iron soil pipe and fittings; [gaskets; and gasketed] [caulking materials; and caulked] joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI,] [heavy-duty,] [cast-iron,] hubless-piping couplings; and coupled joints.
 3. [Solid-wall] [Cellular-core] ABS pipe, ABS socket fittings, and solvent-cemented joints.
 4. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- E. Underground, storm drainage piping [NPS 8 and larger] <Insert pipe size range> is to be [any of] the following:
1. [Extra heavy] [Service weight], cast-iron soil pipe and fittings; [gaskets; and gasketed] [caulking materials; and caulked] joints.
 2. Hubless, cast-iron soil pipe and fittings; [CISPI,] [heavy-duty,] [cast-iron,] hubless-piping couplings; and coupled joints.
 3. [Solid-wall] [Cellular-core] PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- F. Aboveground storm drainage force mains [NPS 1-1/2 and NPS 2] <Insert pipe size range> is to be [any of] the following:
1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- G. Aboveground storm drainage force mains [NPS 2-1/2 to NPS 6] <Insert pipe size range> is to be [any of] the following:
1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 4. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 221414

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:
 - a. Constant-volume air systems.
 - b. Dual-duct systems.
 - c. Variable-air-volume systems.
 - d. Multizone systems.
 - e. Induction-unit systems.
2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
3. Testing, adjusting, and balancing of fuel oil systems for HVAC.
4. Testing, adjusting, and balancing of steam and condensate piping systems.
5. Testing, adjusting, and balancing of equipment.
6. Testing, adjusting, and balancing of existing HVAC systems and equipment.
7. Procedures for exhaust hoods.
8. Sound tests.
9. Vibration tests.
10. Duct leakage tests verification.
11. Pipe leakage tests verification.
12. UFAD plenum leakage tests verification.
13. HVAC-control system verification.
14. Smoke-control system tests.
15. Stair-pressurization system tests.
16. Elevator-pressurization system tests.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.

- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at [Project site] <Insert location> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of [14] <Insert number> days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.4 ACTION SUBMITTALS

- A. Sustainable Design Submittals:
 - 1. Air-Balance Report: Documentation indicating that Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - 2. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
 - 3. HVAC Flush Report: Documentation indicating that building HVAC system flush complies with Green Globes Section 3.1.2.4 "IAQ During Construction."

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within [30] [60] [90] <Insert number> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within [30] [60] [90] <Insert number> days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within [30] [60] [90] <Insert number> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within [30] [60] [90] <Insert number> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by [NEBB] [or] [TABB]:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by [NEBB] [or] [TABB].
2. TAB Technician: Employee of the TAB specialist and certified by [NEBB] [or] [TABB].

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, **[engage one of the following] [available TAB specialists that may be engaged include, but are not limited to, the following]:**

1. <Insert TAB specialist's name>.

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

- Q. 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.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
 2. Strategies and step-by-step procedures for balancing the systems.
 3. Instrumentation to be used.
 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning in accordance with the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [AABC's "National Standards for Total System Balance"] [ASHRAE 111] [NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental

Systems"] and in this Section.

- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
 - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in [**inch-pound (IP)**] [**and**] [**metric (SI)**] units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Pumps.
 - 3. Fans and ventilators.
 - 4. Air curtains.
 - 5. Terminal units.
 - 6. Commercial kitchen hoods.
 - 7. Boilers.
 - 8. Deaerators.
 - 9. Furnaces.
 - 10. Radiant heaters.
 - 11. Unit heaters.
 - 12. Solar collectors.
 - 13. Heat exchangers.
 - 14. Condensing units.
 - 15. Condensers.
 - 16. Water chillers.
 - 17. Cooling towers.
 - 18. Energy-recovery units.
 - 19. Air-handling units.
 - 20. Heating and ventilating units.
 - 21. Rooftop air-conditioning units.
 - 22. Heating-only makeup air units.
 - 23. Dedicated outdoor-air units.
 - 24. Packaged air conditioners.
 - 25. Self-contained air conditioners.

26. Computer-room air conditioners.
27. Split-system air conditioners.
28. Variable-refrigerant-flow systems.
29. Heat pumps.
30. Balance heating and cooling units.
31. Chilled beams.
32. Coils.
33. Fan coil units.
34. Unit ventilators.
35. Radiators.
36. Convectors.
37. Finned-tube radiation heaters.
38. Radiant-heating [cables] [piping] [and] [panels].
39. Humidifiers.
40. Dehumidification units.
41. <Insert equipment>.

3.6 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' Record drawings 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 outdoor-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.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.

- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from [Architect] [Owner] [Construction Manager] [Commissioning Authority] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.
- ### 3.8 PROCEDURES FOR DUAL-DUCT SYSTEMS
- A. Adjust the dual-duct systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge. On

- systems with separate hot-deck and cold-deck fans, verify the location of the sensor on each deck.
2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point, so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 4. Calibrate and balance each terminal unit's hot deck and cold deck for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for full cooling. Some controllers require starting with minimum set point. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factors as required for design cold-deck maximum airflow and hot-deck minimum airflow. Record calibration factors.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for full heating.
 - e. Measure airflow and adjust calibration factors as required for design cold-deck minimum airflow and hot-deck maximum airflow. Record calibration factors. If no minimum calibration is available, note any deviation from design airflow.
 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity (cooling coil or fan), adjust terminals for maximum and minimum airflow so that connected total matches cooling coil or fan selection and simulates actual load in the building. In systems with separate hot-deck and cold-deck fans, diversity consideration applies to each individual fan.
 - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 6. Measure the fan(s) static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 7. Set final return and outside airflow to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets.
 - b. Verify that all terminal units are meeting design airflow under system maximum flow.
 8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.

- b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.
10. Record final fan-performance data.

3.9 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.10 PROCEDURES FOR MULTIZONE SYSTEMS

- A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.
- B. The procedures for multizone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.
- C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.
- D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from [Architect] [Owner] [Construction Manager] [Commissioning Authority] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety

factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- F. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlet and outlet airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- G. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.11 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

- A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser, to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.
- B. Adjust each induction unit.
- C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from [Architect] [Owner] [Construction Manager] [Commissioning Authority] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.
- F. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, speeds, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.12 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
1. Check expansion tank for proper setting.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 5. Verify that motor controllers are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.

- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

- 1. Check settings and operation of each safety valve. Record settings.

3.13 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design flow.

- 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 - 3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

- B. Adjust flow-measuring devices installed in mains and branches to design water flows.

- 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.

- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

- 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.

- D. For systems with pressure-independent valves at terminals:

- 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.

- E. For systems without pressure-independent valves or flow-measuring devices at terminals:

- 1. Measure and balance coils by either coil pressure drop or temperature method.

2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- G. Verify that memory stops have been set.

3.14 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
1. Verify that the pressure-differential sensor(s) is located as indicated.
 2. Determine whether there is diversity in the system.
- C. For systems with no flow diversity:
1. Adjust pumps to deliver total design flow.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gauge heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 - c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.
- D. For systems with flow diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by Architect.
 3. Adjust pumps to deliver total design flow.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gauge heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be

trimmed to reduce excess throttling.

- c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.

3.15 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design flow.

1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- F. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- G. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- H. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 3. Mark final settings.
- I. Verify that memory stops have been set.

3.16 PROCEDURES FOR STEAM AND CONDENSATE SYSTEMS

- A. Measure and record upstream and downstream pressure of each piece of equipment.
- B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.

3.17 PROCEDURES FOR STEAM-TO-WATER HEAT EXCHANGERS

- A. Adjust and record water flow to within specified tolerances.
- B. Measure and record inlet and outlet water temperatures.
- C. Measure and record inlet steam pressure and condensate outlet pressure.
- D. Check and record settings and operation of safety and relief valves.

3.18 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

- A. Adjust and record water flow to within specified tolerances.
- B. Measure and record inlet and outlet water temperatures.
- C. Measure and record pressure drop.
- D. Check and record settings and operation of safety and relief valves.

3.19 PROCEDURES FOR MOTORS

- A. Motors [1/2] <Insert value> HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.20 PROCEDURES FOR WATER CHILLERS

- A. Air-Cooled Chillers: Balance water flow through each evaporator to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 5. Capacity: Calculate in [tons] [kilowatts] <Insert units> of cooling.
 6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
 7. Verify condenser-fan rotation and record fan and motor data, including number of fans and entering- and leaving-air temperatures.
- B. Water-Cooled Chillers: Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 2. Condenser-water entering and leaving temperatures, pressure drop, and water flow.
 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 6. Capacity: Calculate in [tons] [kilowatts] <Insert units> of cooling.
 7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.21 PROCEDURES FOR COOLING TOWERS

- A. Performance Testing: Comply with [CTI ATC-105] [Cooling tower "AABC Performance Test" in AABC's "National Standards for Total System Balance"] <Insert test procedure>.
- B. Closed-Circuit Cooling Towers: Balance total condenser-water flows to towers and cells. Measure and record the following data:
1. Condenser-water flow to each cell of the cooling tower.
 2. Pressure drop through each cell.
 3. Entering- and leaving-water temperatures.
 4. Wet- and dry-bulb temperatures of entering air.
 5. Wet- and dry-bulb temperatures of leaving air.
 6. Barometric pressure, wind speed, and wind direction.
 7. Condenser-water flow rate recirculating through the cooling tower.
 8. Cooling-tower spray pump discharge pressure.
 9. Condenser-water flow through bypass.
 10. Makeup-water flow rate.
 11. Makeup water temperature.
 12. Fan, motor, and motor controller operating data.
 13. Cooling-tower spray pump and motor operating data.

14. Heater operating data.

C. Open-Circuit Cooling Towers: Balance total condenser-water flows to towers and cells. Measure and record the following data:

1. Condenser-water flow to each cell of the cooling tower.
2. Pressure at each inlet connection.
3. Entering- and leaving-water temperatures.
4. Range.
5. Makeup-water flow rate.
6. Makeup water temperature.
7. Wet- and dry-bulb temperatures of entering air.
8. Wet- and dry-bulb temperatures of leaving air.
9. Approach.
10. Barometric pressure, wind speed, and wind direction.
11. Fan, motor, and motor controller operating data.
12. Heater operating data.

3.22 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

3.23 PROCEDURES FOR AIR-COOLED CONDENSERS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of fan(s) and motor(s).

3.24 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Measure and record pressure drop.
 4. **[Measure and]**Record relief valve(s) pressure setting.
 5. Capacity: Calculate in **Btu/h** of heating output.
 6. Fuel Consumption: If boiler fuel supply is equipped with flow meter, measure and record consumption.

7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

B. Steam Boilers:

1. Measure and record entering-water temperature.
2. Measure and record feedwater flow.
3. Measure and record leaving-steam pressure and temperature.
4. **[Measure and]**Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
7. Fan, motor, and motor controller operating data.

C. Boilers with Flue Gas Economizers:

1. Measure and record entering- and leaving-water temperature.
2. Measure and record water flow rate.
3. Measure and record water pressure drop.
4. Heat Recovered: Calculate in **Btu/h** of waste heat recovered.

3.25 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant 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. Entering and leaving refrigerant pressure and temperatures.

3.26 PROCEDURES FOR EXHAUST HOODS

- A. Room Pressure: Measure and record room pressure with respect to atmosphere and adjacent space with hoods in room initially not operating and then with hoods operating.
- B. Makeup Air: Systems supplying source of makeup air to hoods shall be in operation during testing and balancing of exhaust hoods.
 1. Measure and record temperature of makeup air entering hood. If hood makeup air is from multiple sources having different temperatures, measure and record the airflow and temperatures of each source and calculate the weighted average temperature.
 2. Use simulated smoke to observe supply air-distribution air patterns in vicinity of hoods. Consult with hood manufacturer and report conditions that have a detrimental effect on intended capture, containment, and other attributes effecting proper operation.
- C. Rooms with Multiple Hoods: Test each hood separately, one at a time, and repeat tests with all hoods intended to operate simultaneously by design.
- D. Canopy Hoods: Measure and record the following:
 1. Pressure drop across hood.
 2. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity.
 3. Measure velocity across hood face and calculate hood airflow.
 - a. Clearly indicate the direction of flow at each point of measurement.
 - b. Measure velocity across opening on not less than [12-inch] <Insert dimension> centers. Record velocity at each measurement, and calculate average velocity.
 4. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.
- E. Laboratory Fume Hoods: Measure and record the following:
 1. Pressure drop across hood.
 2. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity. If hood is connected to exhaust duct distribution through an exhaust device with integral airflow measurement, that reading may be used in lieu of a duct traverse.
 3. Face velocity across open hood face and calculate hood airflow.
 - a. Clearly indicate the direction of flow at each point of measurement.
 - b. Measure velocity across opening on not less than [6-inch] <Insert dimension> centers. Record velocity at each measurement, and calculate average velocity.
 4. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and

- report performance. Make adjustments to achieve optimum results.
5. ASHRAE 110 Testing: With room and laboratory fume hood operating at design conditions, perform an "as-installed" performance test of the laboratory fume hood in accordance with ASHRAE 110. Test **[each]** **[indicate extent]** laboratory fume hood and document the test results.
- F. Kitchen Hoods:
1. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's instructions. Consult hood manufacturer to determine hood airflow using recorded information.
 2. Type 2: Measure and record airflow by duct traverse.
 3. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.
- G. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

3.27 SOUND TESTS

- A. After systems are balanced and Substantial Completion, measure and record sound levels at **[five]** **[10]** **[15]** **<Insert number>** locations as designated by the Architect.
- B. Instrumentation:
1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (Leq).
 3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 2. Equipment should be operating at design values.
 3. Calibrate the sound-testing meter prior to taking measurements.
 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
 5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands **[63 Hz to 8000 Hz (NC)]** **[31.5 Hz to 4000 Hz (RC)]** with the equipment off.
 6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands **[63 Hz to 8000 Hz (NC)]** **[31.5 Hz to 4000 Hz (RC)]** with the equipment operating.
 7. Take readings no closer than **36 inches** from a wall or from the operating equipment and approximately **60 inches** from the floor, with the meter held or mounted on a tripod.
 8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.
- D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on **[Noise Criteria (NC)]** [or] **[Room Criteria (RC)]** worksheet with equipment on and off.

3.28 VIBRATION TESTS

- A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than **[10]** **[15]** **[25]** <insert number>.
- B. Instrumentation:
 1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
 1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
 3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
 4. Record CPM or rpm.
 5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
 1. Report shall record location and the system tested.
 2. Include horizontal-vertical-axial measurements for tests.
 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
 4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.29 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.

- C. Report deficiencies observed.

3.30 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.31 UFAD PLENUM LEAKAGE TESTS

- A. Witness the UFAD plenum pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.32 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify HVAC control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.33 PROCEDURES FOR STAIR-PRESSURIZATION SYSTEMS

- A. Before testing, observe each pressurized stair enclosure to verify construction is complete. Verify the following:
 - 1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
 - 2. Firestopping and sealants are installed.
 - 3. Doors, door closers, and door gaskets are installed and adjusted.
 - 4. If applicable, window installation is complete.
 - 5. Stair-pressurization fans and associated controls are installed and functioning properly.
 - 6. Stair-pressurization duct distribution and air outlets are installed.
 - 7. Life-safety dampers (smoke or combination fire and smoke) are installed and functioning properly.

- B. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.
- C. Test each stair enclosure as a single system. If multiple fans serve a single stair enclosure, operate fans as intended by the design.
- D. Initial Air Balance:
 - 1. Open doors to floors where indicated by design and measure, adjust, and record the airflow of each:
 - a. Stair-pressurization fan. For ducted systems, measure fan airflow by duct Pitot-tube traverse unless duct distribution does not permit accurate readings.
 - b. Air outlet supplying stair enclosure.
 - c. Adjust enclosure total airflow to achieve design pressurization.
 - d. Adjust method of stair enclosure pressure relief to prevent overpressurization.
- E. Pressurization Test and Adjustments:
 - 1. After air balancing is complete, perform stair enclosure pressurization tests.
 - 2. Establish a consistent procedure for recording data throughout entire test.
 - 3. Use stair side of doors as pressure reference point.
 - a. Positive Pressure: Floor side of door higher than stair side.
 - b. Negative Pressure: Floor side of door lower than stair side.
 - 4. With HVAC systems and stair-pressurization systems off, measure and record the following:
 - a. Pressure difference across each stair enclosure door, with all doors in the stair enclosure closed.
 - b. Force necessary to open each door, using a spring-type scale.
 - c. Adjustment needed to achieve design pressurization of enclosure total airflow.
 - d. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.
 - 5. With HVAC systems operating in normal mode and stair-pressurization systems off, measure and record the following:
 - a. Pressure difference across each stair enclosure door, with all doors in the stair enclosure closed.
 - b. Force necessary to open each door, using a spring-type scale.
 - c. Adjustment needed to achieve design pressurization of enclosure total airflow.
 - d. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.
 - 6. With HVAC systems and stair-pressurization system operating simultaneously, perform the following:
 - a. Place HVAC systems in normal operating mode, including equipment not used to implement smoke control, such as air-handling units, exhaust fans, and similar equipment.
 - b. Measure and record pressure difference across each stair enclosure door, with all doors in stair enclosure closed.
 - c. Use a spring scale to measure and record the force needed to open all stair enclosure doors.
 - d. Adjust enclosure total airflow to achieve design pressurization.
 - e. Adjust method of stair enclosure pressure relief to prevent overpressurization.
 - f. Additional Tests for Designs with Open Doors:
 - 1) With exit door to outdoors in open position, measure and record pressure difference across each of the remaining closed stair enclosure doors.
 - 2) Open additional doors (up to the number indicated by design) one at a time, and measure and record

- pressure difference across each remaining closed stair enclosure door after the opening of each additional door.
- 3) For each different test condition, measure and record the direction and velocity through each of the open doors by a traverse of every [1 sq. ft.] <Insert requirement> grid of door opening.
 - 4) For each different test condition, calculate average of door velocity measurements. Compare average velocity to design and governing code requirements.
 - 5) Adjust enclosure total airflow to achieve design pressurization.
 - 6) Adjust method of stair enclosure pressure relief to prevent overpressurization.
7. Repeat pressurization tests with the smoke-control systems and HVAC systems operating.
 8. Criteria for Acceptance:
 - a. Compliance with design requirements.
 - b. Compliance with code requirements.
 - c. Compliance with additional requirements required by authorities having jurisdiction.
 - d. <Insert other criteria>.

F. Operational Tests:

1. Check proper activation of stair-pressurization system(s) in response to all means of activation, both automatic and manual.
2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:
 - a. Normal.
 - b. Alarm.
 - c. Manual override.
 - d. Return to normal.
3. Verify smoke detector at pressurization fan de-energizes fan and closes isolation damper when smoke detector is activated and in alarm.
4. If standby power is provided for pressurization systems, test to verify pressurization systems operate while on both normal and standby power.
5. Check operation in accordance with design indicated.

G. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

H. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.

3.34 PROCEDURES FOR ELEVATOR-PRESSURIZATION SYSTEMS

A. Before testing, observe each pressurized elevator enclosure to verify construction is complete. Verify the following:

1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
2. Firestopping and sealants are installed.
3. Doors are installed and adjusted. Elevator car doors are recalled to the default recall floor, and elevator car doors on recall floor are open.
4. If applicable, window installation is complete.
5. Pressurization fans and associated controls are installed and functioning properly.

6. Pressurization duct distribution and air outlets are installed.
 7. Life-safety dampers (smoke or combination fire and smoke) are installed and functioning properly.
- B. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.
- C. Test each elevator enclosure as a single system. If multiple fans serve a single elevator enclosure, operate fans as intended by the design.
- D. Initial Air Balance:
1. Open elevator car doors to recall floor indicated by design, and measure, adjust, and record the airflow of each:
 - a. Pressurization fan. For ducted systems, measure fan airflow by duct pitot-tube traverse unless duct distribution does not permit accurate readings.
 - b. Air outlet supplying elevator enclosure.
 - c. Adjustment needed to achieve design pressurization of enclosure total airflow.
 - d. Adjustment to method of elevator enclosure pressure relief, to prevent overpressurization.
- E. Pressurization Tests and Adjustments:
1. After air balancing is complete, perform elevator enclosure pressurization tests.
 2. Establish a consistent procedure for recording data throughout entire test.
 3. Use elevator car side of doors as pressure reference point.
 - a. Positive Pressure: Floor side of door higher than elevator car side.
 - b. Negative Pressure: Floor side of door lower than elevator car side.
 4. With HVAC systems and elevator-pressurization systems off, measure and record the following:
 - a. Pressure difference across each elevator enclosure door with all doors in the elevator enclosure closed.
 - b. Adjustment needed to achieve design pressurization of enclosure total airflow.
 - c. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.
 5. With HVAC systems operating in normal mode and elevator pressurization systems off, measure and record the following:
 - a. Pressure difference across each elevator enclosure door with all doors in the elevator enclosure closed.
 - b. Adjustment needed to achieve design pressurization of enclosure total airflow.
 - c. Adjustment needed to method of stair enclosure pressure relief, to prevent overpressurization.
 6. With HVAC systems and elevator pressurization system operating simultaneously, perform the following:
 - a. Place HVAC systems in normal operating mode, including equipment not used to implement smoke control, such as air-handling units, exhaust fans, and similar equipment.
 - b. Measure and record pressure difference across each stair enclosure door, with all doors in stair enclosure closed.
 - c. Adjust enclosure total airflow to achieve design pressurization.
 - d. Adjust method of elevator enclosure pressure relief to prevent overpressurization.
 7. Repeat pressurization tests with smoke-control systems and HVAC systems operating.
 8. Criteria for Acceptance:

- a. Compliance with design requirements.
- b. Compliance with code requirements.
- c. Compliance with additional requirements of authorities having jurisdiction.
- d. <Insert other criteria>.

F. Operational Tests:

- 1. Check proper activation of elevator-pressurization system(s) in response to all means of activation, both automatic and manual.
- 2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:
 - a. Normal.
 - b. Alarm.
 - c. Manual override.
 - d. Return to normal.
- 3. Verify smoke detector at pressurization fan de-energizes fan and closes isolation damper when smoke detector is activated and in alarm.
- 4. If standby power is provided for pressurization systems, test to verify pressurization systems operate while on both normal and standby power.
- 5. Check operation according to design indicated.

G. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

H. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.

3.35 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

- A. Before testing smoke-control systems, review design documents to understand operating requirements and design intent:
 - 1. Review boundaries of each smoke zone.
 - 2. Review location, size, and operating characteristics of equipment, such as smoke and fire smoke dampers.
 - 3. Review sequence of operation, operating status of equipment, and position of smoke and fire dampers for each smoke zone alarm condition.
 - 4. Review location and type of alarm detection used to initiate smoke control for each smoke zone.
 - 5. Review other smoke-control system attributes not listed but required for code compliance and acceptance by authorities having jurisdiction.
- B. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary.
 - 1. Verify that windows, doors, walls, ceilings, and floors (six-sided boundary) are closed and that applicable safing, gasket, and firestops and sealants are installed.
 - 2. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- C. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.
- D. Measure, adjust, and record airflow of each smoke-control system, with all fans that are a part of system operating as intended by the

design.

1. Measure, adjust, and record the airflow of each fan. For ducted systems, measure fan airflow by duct Pitot-tube traverse.
2. Measure, adjust, and record the airflow of each exhaust inlet and supply outlet.
3. Measure, adjust, and record airflow in main and branch ducts.

E. Smoke Control by Pressurization: After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system designed for isolation by using pressurization boundaries:

1. Verify the boundaries of each smoke-control zone.
2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high- and low-pressure side of each door.
3. With the system operating in the smoke-control mode and with each separate zone in the smoke-control system activated, perform the following:
 - a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones.
 - 1) Make measurements with doors that separate the smoke zone from the other zones closed.
 - 2) Clearly indicate the high- and low-pressure side of the door.
 - 3) Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.
 - b. Continue to activate each separate smoke zone within each smoke-control system, and make pressure-difference measurements.
 - c. After testing a smoke zone's smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone's smoke-control system.
 - d. Verify that controls necessary to prevent excessive pressure differences are functional and operating within design set points and limits.

F. Smoke-Control Systems for Atriums and Other Large-Volume Spaces: After air balancing is complete, perform the following testing for each smoke-control system serving atriums and other large-volume spaces:

1. Verify and document the boundaries served by each smoke-control system.
2. Identify and document closed doors, open doors, and other boundary openings to be left open to adjacent areas and that are to be protected by airflow alone.
3. With the HVAC systems in their normal mode of operation and smoke-control systems not operating, measure and record the following:
 - a. Pressure difference across each door that separates the smoke-zone from adjacent zones.
 - b. Velocity for each point in traverse across each boundary opening:
 - 1) Clearly indicate the direction of flow.
 - 2) Measure velocity across opening on [12-inch] <Insert dimension> centers using a vane anemometer.
 - 3) Calculate and report airflow.
4. With system operating in the smoke-control mode, measure and record the following:
 - a. Pressure difference across each door that separates the smoke-zone from adjacent zones.

- b. Velocity for each point in traverse across each opening:
 - 1) Clearly indicate the direction of flow.
 - 2) Measure velocity across opening on [12-inch] <Insert dimension> centers using a vane anemometer.
 - 3) Calculate and report airflow.
 - 5. Verify system operation and make adjustments to achieve design pressure differences and air velocities within design set points and upper operating limits.
 - G. Operational Tests:
 - 1. Check the proper activation of each zone of each smoke-control system in response to all means of activation, both automatic and manual.
 - 2. Check automatic activation in response to fire alarm signals received from the building's fire alarm system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zone of each smoke-control system occurs.
 - 3. Check and record proper operation of fans, dampers, and related equipment for each separate zone of each smoke-control system:
 - a. Zone in which a smoke-control system automatically activates.
 - b. Type of signal that activates smoke-control system, such as sprinkler flow or smoke detector.
 - c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.
 - d. Positive-pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
 - e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted to verify that the intended control configuration is achieved.
 - f. Fan(s) "OFF" as required to implement the smoke-control system.
 - g. Damper(s) "OPEN" or at an adjustable position where maximum airflow must be achieved.
 - h. Damper(s) "CLOSED" where no airflow should take place.
 - i. Auxiliary functions to achieve the smoke-control system configuration, such as changes or override of normal operating pressure and temperature-control set points.
 - j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.
 - k. Check operation in accordance with design indicated.
 - H. AHJ Tests: Conduct additional tests required by authorities having jurisdiction. **[Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.]**
 - I. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.
- 3.36 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS
- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
 - 2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.

3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 4. Check the refrigerant charge.
 5. Check the condition of filters.
 6. Check the condition of coils.
 7. Check the operation of the drain pan and condensate-drain trap.
 8. Check bearings and other lubricated parts for proper lubrication.
 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than [5] <Insert number> percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is [5] <Insert number> percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.37 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: [Plus or minus 10 percent] [Plus 10 percent or minus 5 percent] <Insert value>. If design value is less than 100 cfm, within 10 cfm.
 2. Air Outlets and Inlets: [Plus or minus 10 percent] [Plus 10 percent or minus 5 percent] <Insert value>. If design value is less than 100 cfm, within 10 cfm.
 3. Heating-Water Flow Rate: [Plus or minus 5 percent] [Plus or minus 10 percent] [Plus 10 percent or minus 5 percent] <Insert value>. If design value is less than 10 gpm, within 10 percent.
 4. Chilled-Water Flow Rate: [Plus or minus 5 percent] [Plus or minus 10 percent] [Plus 10 percent or minus 5 percent] <Insert value>. If design value is less than 10 gpm, within 10 percent.
 5. Condenser-Water Flow Rate: [Plus or minus 5 percent] [Plus or minus 10 percent] [Plus 10 percent or minus 5 percent] <Insert value>.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.38 PROGRESS 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 system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare [weekly] [biweekly] [monthly] <Insert time interval> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.39 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Face and bypass damper settings at coils.
 - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - g. **[Variable-frequency controller]** **[Inlet vane]** settings for variable-air-volume systems.
 - h. Settings for pressure controller(s).
 - i. Other system operating conditions that affect performance.
 16. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in **inches**, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in **inches**.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and speed.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in **inches**, and bore.
- f. Center-to-center dimensions of sheave and amount of adjustments in **inches**.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in **cfm**.
- b. Total system static pressure in **inches wg**.
- c. Fan speed.
- d. Inlet and discharge static pressure in **inches wg**.
- e. For each filter bank, filter static-pressure differential in **inches wg**.
- f. Preheat-coil static-pressure differential in **inches wg**.
- g. Cooling-coil static-pressure differential in **inches wg**.
- h. Heating-coil static-pressure differential in **inches wg**.
- i. List for each internal component with pressure-drop, static-pressure differential in **inches wg**.
- j. Outdoor airflow in **cfm**.
- k. Return airflow in **cfm**.
- l. Outdoor-air damper position.
- m. Return-air damper position.
- n. **[Vortex damper position]**.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in **fins per inch o.c.**
- f. Make and model number.
- g. Face area in **sq. ft.**
- h. Tube size in **NPS**.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in **cfm**.
- b. Average face velocity in **fpm**.
- c. Air pressure drop in **inches wg**.
- d. Outdoor-air, wet- and dry-bulb temperatures in **deg F**.
- e. Return-air, wet- and dry-bulb temperatures in **deg F**.
- f. Entering-air, wet- and dry-bulb temperatures in **deg F**.
- g. Leaving-air, wet- and dry-bulb temperatures in **deg F**.
- h. Water flow rate in **gpm**.

- i. Water pressure differential in **feet of head or psig**.
 - j. Entering-water temperature in **deg F**.
 - k. Leaving-water temperature in **deg F**.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in **psig**.
 - n. Refrigerant suction temperature in **deg F**.
 - o. Inlet steam pressure in **psig**.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in **Btu/h**.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and speed.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in **inches**, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in **inches**.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in **cfm**.
 - b. Entering-air temperature in **deg F**.
 - c. Leaving-air temperature in **deg F**.
 - d. Air temperature differential in **deg F**.
 - e. Entering-air static pressure in **inches wg**.
 - f. Leaving-air static pressure in **inches wg**.
 - g. Air static-pressure differential in **inches wg**.
 - h. Low-fire fuel input in **Btu/h**.
 - i. High-fire fuel input in **Btu/h**.
 - j. Manifold pressure in **psig**.
 - k. High-temperature-limit setting in **deg F**.
 - l. Operating set point in **Btu/h**.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in **Btu/h**.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:

- a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in **Btu/h.**
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in **cfm.**
 - i. Face area in **sq. ft.**
 - j. Minimum face velocity in **fpm.**
 2. Test Data (Indicated and Actual Values):
 - a. Heat output in **Btu/h.**
 - b. Airflow rate in **cfm.**
 - c. Air velocity in **fpm.**
 - d. Entering-air temperature in **deg F.**
 - e. Leaving-air temperature in **deg F.**
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in **inches**, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in **inches.**
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in **inches**, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in **inches.**
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in **cfm.**
 - b. Total system static pressure in **inches wg.**
 - c. Fan speed.

- d. Discharge static pressure in **inches wg.**
 - e. Suction static pressure in **inches wg.**
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System fan and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in **deg F.**
 - d. Duct static pressure in **inches wg.**
 - e. Duct size in **inches.**
 - f. Duct area in **sq. ft.**
 - g. Indicated airflow rate in **cfm.**
 - h. Indicated velocity in **fpm.**
 - i. Actual airflow rate in **cfm.**
 - j. Actual average velocity in **fpm.**
 - k. Barometric pressure in **psig.**
- K. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in **sq. ft.**
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in **cfm.**
 - b. Air velocity in **fpm.**
 - c. Preliminary airflow rate as needed in **cfm.**
 - d. Preliminary velocity as needed in **fpm.**
 - e. Final airflow rate in **cfm.**
 - f. Final velocity in **fpm.**
 - g. Space temperature in **deg F.**
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.

- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in **cfm**.
- b. Entering-water temperature in **deg F**.
- c. Leaving-water temperature in **deg F**.
- d. Water pressure drop in **feet of head or psig**.
- e. Entering-air temperature in **deg F**.
- f. Leaving-air temperature in **deg F**.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in **gpm**.
- g. Water pressure differential in **feet of head or psig**.
- h. Required net positive suction head in **feet of head or psig**.
- i. Pump speed.
- j. Impeller diameter in **inches**.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in **feet of head or psig**.
- b. Pump shutoff pressure in **feet of head or psig**.
- c. Actual impeller size in **inches**.
- d. Full-open flow rate in **gpm**.
- e. Full-open pressure in **feet of head or psig**.
- f. Final discharge pressure in **feet of head or psig**.
- g. Final suction pressure in **feet of head or psig**.
- h. Final total pressure in **feet of head or psig**.
- i. Final water flow rate in **gpm**.
- j. Voltage at each connection.
- k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.40 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of [Architect] [Owner] [Construction Manager] [Commissioning Authority].
- B. [Architect] [Owner] [Construction Manager] [Commissioning Authority] shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either [10] <Insert number> percent of the total measurements recorded or the extent of measurements that can be accomplished in [a normal 8-hour business day] <Insert value>.
- C. If 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."
- D. If the number of "FAILED" measurements is greater than [10] [20] <Insert number> percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.41 ADDITIONAL TESTS

- A. Within [90] <Insert number> days of completing TAB, perform additional TAB 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 TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Copper tube and fittings.~~
- ~~2.1. Steel pipe and fittings.~~
- ~~3. Valves and specialties.~~
- ~~4. Refrigerants.~~

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

- ~~1. Solenoid valves.~~
- ~~2. Thermostatic expansion valves.~~
- ~~3. Hot-gas bypass valves.~~
- ~~4. Strainers.~~
- ~~5. Filter driers.~~
- ~~6. Pressure-regulating valves.~~
- ~~7. Mufflers.~~

B. Product Data Submittals: For each product.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Sustainable Design Submittals:

1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
2. Product Data: For refrigerants, indicating compliance with refrigerant management practices.

E. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: [~~1/4 inch equals 1 foot~~] <Insert value>.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: For each welder performing shop or field welding on Project.
- B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.
- B. Prepare valves and specialties for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads and other end connections.
- C. Use the following precautions during storage:
 - 1. Maintain valve and specialty end protection.
 - 2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- B. Comply with ASHRAE 15.
- C. Comply with ASME B31.5.
- D. Test Pressure for Refrigerant R-134a:

1. Suction Tubing Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [115 psig] <Insert pressure>.
 2. Suction Tubing for Heat-Pump Applications: [225 psig] <Insert pressure>.
 3. Hot-Gas and Liquid Tubing: [225 psig] <Insert pressure>.
- E. Test Pressure for Refrigerant R-407C:
1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [230 psig] <Insert pressure>.
 2. Suction Tubing for Heat-Pump Applications: [380 psig] <Insert pressure>.
 3. Hot-Gas and Tubing Lines: [380 psig] <Insert pressure>.
- F. Test Pressure for Refrigerant R-410A:
1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: [300 psig] <Insert pressure>.
 2. Suction Tubing for Heat-Pump Applications: [535 psig] <Insert pressure>.
 3. Hot-Gas and Tubing Lines: [535 psig] <Insert pressure>.

2.2 — ~~COPPER TUBE AND FITTINGS~~

- A. — ~~Copper Tube: [ASTM B88, Type K or L] [ASTM B280, Type ACR].~~
- B. — ~~Wrought-Copper Fittings, Solder Joint: ASME B16.22.~~
- C. — ~~Wrought-Copper Fittings, Brazed Joint: ASME B16.50.~~
- D. — ~~Wrought-Copper Unions: ASME B16.22.~~
- E. — ~~Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.~~
- F. — ~~Brazing Filler Metals: AWS A5.8M/A5.8.~~
- G. — ~~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. — ~~Working Pressure Rating: Factory test at minimum [500 psig] <Insert pressure rating>.~~
 5. — ~~Maximum Operating Temperature: [250 deg F] <Insert temperature>.~~

2.32.2 ~~STEEL PIPE AND FITTINGS~~

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.
- B. Wrought-Steel Fittings: ASTM A234/A234M, for welded joints.
- C. Steel Flanges and Flanged Fittings: ASME B16.5 steel, including bolts, nuts, gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 and ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for **NPS 1 to NPS 1-1/2** and ductile iron for **NPS 2 to NPS 3**. Factory apply rust-resistant finish.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Factory apply rust-resistant finish.
4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
5. Offset Performance: Capable of minimum **3/4-inch** misalignment in minimum **7-inch** long assembly.
6. Pressure Rating: Factory test at minimum **[400 psig]** <Insert pressure>.
7. Maximum Operating Temperature: **330 deg F**.

F. Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, stainless steel-wire-reinforced protective jacket.
2. End Connections:
 - a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.
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]** <Insert pressure>.
5. Maximum Operating Temperature: **[250 deg F]** <Insert temperature>.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

- A. Refrigerant: **[R-134a]** **[R-407C]** **[R-410A]**
- B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.
- C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller: Copper, **[Type ACR]** **[Type L]**, drawn-temper tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.
- D. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, **[Type ACR]** **[Type L]**, drawn-temper tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.
- E. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: **[Type ACR]** **[Type K]** **[or]** **[Type L]**, **[drawn-temper]** **[or]** **[annealed-temper]** tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.
- F. Safety-Relief-Valve Discharge Piping for Conventional Air-Conditioning (Cooling-Only) Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.
- G. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.
- H. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 (DN 100) and Smaller: Copper, **[Type ACR]** **[Type L]**, drawn-temper tubing and wrought-copper fittings with **[brazed]** **[or]** **[soldered]** joints.

- I. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, [Type ACR] [Type L], drawn-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.
- J. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: [Type ACR] [Type K] [or] [Type L], [drawn-temper] [or] [annealed-temper] tubing and wrought-copper fittings with [brazed] [or] [soldered] joints
- K. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install [diaphragm packless] [packed-angle] valves in suction and discharge lines of compressor.
- B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install [diaphragm packless] [packed-angle] valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. 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.
- H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.
- I. 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.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve[, and in the suction line at the compressor].
- L. Install receivers sized to accommodate pump-down charge.

- M. Install flexible connectors at compressors.
- N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

- 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 in accordance with 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 Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" 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 Section 083113 "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, 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 piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

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 in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."
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.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than **20 ft.** long.
 - 2. Roller hangers and spring hangers for individual horizontal runs **20 ft.** or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft.** 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.
- D. Install hangers for **[copper tubing]** **[and]** **[steel piping]**, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within **[12 inches]** **<Insert dimension>** of each fitting.
- F. Support vertical runs of **[copper tubing]** **[and]** **[steel piping]** to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- 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 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System must maintain test pressure at the manifold gauge 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.
- C. Prepare test and inspection reports.

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, in accordance with 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 but not 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 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adjustable blade face [registers] [and] [grilles].
2. Fixed face [registers] [and] [grilles].
- ~~3. Linear bar grilles.~~

~~B. Related Requirements:~~

- ~~1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.~~
- ~~2. Section 233713.13 "Air Diffusers" for various types of air diffusers.~~
- ~~3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.~~
- ~~4. Section 233716 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.

C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.

D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate 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 registers and grilles are 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 registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install 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 registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Ductless fan coil units.~~
- ~~2. Ducted fan coil units.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of fan coil unit indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which fan coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

- a. Lighting fixtures.

- b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. <Insert item>.
- 6. Perimeter moldings.
- B. Seismic Qualification Certificates: For fan coil units, 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. 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.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Coil Unit Filters: Furnish <Insert number> spare filters for each filter installed.
 - 2. Fan Belts: Furnish <Insert number> spare fan belts for each unit installed.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: **[Four]** **[Five]** **[10]** <Insert number> years from date of Substantial Completion.
 - 3. Warranty Period (Compressor Only): **[Five]** **[10]** <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- 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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN COIL UNITS

- A. Install fan coil units level and plumb.

- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices [48 inches] [60 inches] <Insert dimension> above finished floor.
- E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections [with the assistance of a factory-authorized service representative]:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. [~~Engage a factory-authorized service representative to train~~] [Train] Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies supplemental requirements generally applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions.
- B. Related Requirements:
 - 1. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 REFERENCES

- A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:
 - 1. 8P8C: An 8-position 8-contact modular jack.
 - 2. A: Ampere, unit of electrical current.
 - 3. AC or ac: Alternating current.
 - 4. AFCI: Arc-fault circuit interrupter.
 - 5. AIC: Ampere interrupting capacity.
 - 6. AL, Al, or ALUM: Aluminum.
 - 7. ASD: Adjustable-speed drive; also called "variable-frequency drive" (VFD).
 - 8. ATS: Automatic transfer switch.
 - 9. AWG: American wire gauge; see ASTM B258.
 - 10. BAS: Building automation system.
 - 11. BIL: Basic impulse insulation level.
 - 12. BIM: Building information modeling.
 - 13. CAD: Computer-aided design or drafting.
 - 14. CATV: Community antenna television.
 - 15. CB: Circuit breaker.
 - 16. cd: Candela, the SI fundamental unit of luminous intensity.
 - 17. CO/ALR: Copper-aluminum, revised.
 - 18. COPS: Critical operations power system.
 - 19. CU or Cu: Copper.
 - 20. CU-AL or AL-CU: Copper-aluminum.
 - 21. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
 - 22. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
 - 23. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
 - 24. dBm: Decibel absolute power with respect to 1 mW.
 - 25. DC or dc: Direct current.
 - 26. DCOA: Designated critical operations area.
 - 27. DDC: Direct digital control (HVAC).

- 28. EGC: Equipment grounding conductor.
- 29. ELV: Extra-low voltage.
- 30. EMF: Electromotive force.
- 31. EMI: Electromagnetic interference.
- 32. EPM: Electrical preventive maintenance.
- 33. EPS: Emergency power supply.
- 34. EPSS: Emergency power supply system.
- 35. ESS: Energy storage system.
- 36. EV: Electric vehicle.
- 37. EVPE: Electric vehicle power export equipment.
- 38. EVSE: Electric vehicle supply equipment.
- 39. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion $1 \text{ fc} = 10 \text{ lx}$ in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
- 40. FLC: Full-load current.
- 41. ft: Foot.
- 42. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"
- 43. GEC: Grounding electrode conductor.
- 44. GFCI: Ground-fault circuit interrupter.
- 45. GFPE: Ground-fault protection of equipment.
- 46. GND: Ground.
- 47. HACR: Heating, air conditioning, and refrigeration.
- 48. HDPE: High-density polyethylene.
- 49. HID: High-intensity discharge.
- 50. HP or hp: Horsepower.
- 51. HVAC: Heating, ventilating, and air conditioning.
- 52. Hz: Hertz.
- 53. IBT: Intersystem bonding termination.
- 54. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
- 55. IP: Ingress protection rating (enclosures); Internet protocol (communications).
- 56. IR: Infrared.
- 57. IS: Intrinsically safe.
- 58. IT&R: Inspecting, testing, and repair.
- 59. ITE: Information technology equipment.
- 60. kAIC: Kiloampere interrupting capacity.
- 61. kcmil or MCM: One thousand circular mils.
- 62. kV: Kilovolt.
- 63. kVA: Kilovolt-ampere.
- 64. kVA_r or kVAR: Kilovolt-ampere reactive.
- 65. kW: Kilowatt.
- 66. kWh: Kilowatt-hour.
- 67. LAN: Local area network.
- 68. lb: Pound (weight).
- 69. lbf: Pound (force).
- 70. LCD: Liquid-crystal display.
- 71. LCDI: Leakage-current detector-interrupter.
- 72. LED: Light-emitting diode.

- 73. Li-ion: Lithium-ion.
- 74. lm: Lumen, the SI derived unit of luminous flux.
- 75. LNG: Liquefied natural gas.
- 76. LP-Gas: Liquefied petroleum gas.
- 77. LRC: Locked-rotor current.
- 78. LV: Low voltage.
- 79. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.
- 80. m: Meter.
- 81. MCC: Motor-control center.
- 82. MDC: Modular data center.
- 83. MG set: Motor-generator set.
- 84. MIDI: Musical instrument digital interface.
- 85. MLO: Main lugs only.
- 86. MV: Medium voltage.
- 87. MVA: Megavolt-ampere.
- 88. mW: Milliwatt.
- 89. MW: Megawatt.
- 90. MWh: Megawatt-hour.
- 91. NC: Normally closed.
- 92. Ni-Cd: Nickel-cadmium.
- 93. Ni-MH: Nickel-metal hydride.
- 94. NIU: Network interface unit.
- 95. NO: Normally open.
- 96. NPT: National (American) standard pipe taper.
- 97. OCPD: Overcurrent protective device.
- 98. ONT: Optical network terminal.
- 99. PC: Personal computer.
- 100. PCS: Power conversion system.
- 101. PCU: Power-conditioning unit.
- 102. PF or pf: Power factor.
- 103. PHEV: Plug-in hybrid electric vehicle.
- 104. PLC: Programmable logic controller.
- 105. PLFA: Power-limited fire alarm.
- 106. PoE: Power over Ethernet.
- 107. PV: Photovoltaic.
- 108. PVC: Polyvinyl chloride.
- 109. pW: Picowatt.
- 110. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
- 111. RMS or rms: Root-mean-square.
- 112. RPM or rpm: Revolutions per minute.
- 113. SCADA: Supervisory control and data acquisition.
- 114. SCR: Silicon-controlled rectifier.
- 115. SPD: Surge protective device.
- 116. sq.: Square.
- 117. SWD: Switching duty.
- 118. TCP/IP: Transmission control protocol/Internet protocol.
- 119. TEFC: Totally enclosed fan-cooled.
- 120. TR: Tamper resistant.
- 121. TVSS: Transient voltage surge suppressor.

- 122. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.
- 123. UL CCN: UL Category Control Number.
- 124. UPS: Uninterruptible power supply.
- 125. USB: Universal serial bus.
- 126. UV: Ultraviolet.
- 127. V: Volt, unit of electromotive force.
- 128. V(ac): Volt, alternating current.
- 129. V(dc): Volt, direct current.
- 130. VA: Volt-ampere, unit of complex electrical power.
- 131. VAR: Volt-ampere reactive, unit of reactive electrical power.
- 132. VFC: Variable-frequency controller.
- 133. VOM: Volt-ohm-multimeter.
- 134. VPN: Virtual private network.
- 135. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
- 136. W: Watt, unit of real electrical power.
- 137. Wh: Watt-hour, unit of electrical energy usage.
- 138. WPT: Wireless power transfer.
- 139. WPTE: Wireless power transfer equipment.
- 140. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

- 1. CR: Communications raceway.
- 2. CR-GP: General-purpose communications raceway.
- 3. CR-P: Plenum communications raceway.
- 4. CR-R: Riser communications raceway.
- 5. EMT: Electrical metallic tubing.
- 6. EMT-A: Aluminum electrical metallic tubing.
- 7. EMT-S: Steel electrical metallic tubing.
- 8. EMT-SS: Stainless steel electrical metallic tubing.
- 9. ENT: Electrical nonmetallic tubing.
- 10. EPEC: Electrical HDPE underground conduit (thin wall).
- 11. EPEC-A: Type A electrical HDPE underground conduit.
- 12. EPEC-B: Type B electrical HDPE underground conduit.
- 13. ERM: Electrical rigid metal conduit.
- 14. ERM-A: Aluminum electrical rigid metal conduit.
- 15. ERM-S: Steel electrical rigid metal conduit.
- 16. ERM-S-G: Galvanized-steel electrical rigid metal conduit.
- 17. ERM-S-PVC: PVC-coated-steel electrical rigid metal conduit.
- 18. ERM-SS: Stainless steel electrical rigid metal conduit.
- 19. FMC: Flexible metal conduit.
- 20. FMC-A: Aluminum flexible metal conduit.
- 21. FMC-S: Steel flexible metal conduit.
- 22. FMT: Steel flexible metallic tubing.
- 23. FNMC: Flexible nonmetallic conduit. See "LFNC."
- 24. HDPE: HDPE underground conduit (thick wall).
- 25. HDPE-40: Schedule 40 HDPE underground conduit.
- 26. HDPE-80: Schedule 80 HDPE underground conduit.
- 27. IMC: Steel electrical intermediate metal conduit.

28. LPMC: Liquidtight flexible metal conduit.
29. LPMC-A: Aluminum liquidtight flexible metal conduit.
30. LPMC-S: Steel liquidtight flexible metal conduit.
31. LPMC-SS: Stainless steel liquidtight flexible metal conduit.
32. LFNC: Liquidtight flexible nonmetallic conduit.
33. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
34. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
35. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
36. OFR: Optical fiber raceway.
37. OFR-GP: General-purpose optical fiber raceway.
38. OFR-P: Plenum optical fiber raceway.
39. OFR-R: Riser optical fiber raceway.
40. PVC: Rigid PVC conduit.
41. PVC-40: Schedule 40 rigid PVC conduit.
42. PVC-80: Schedule 80 rigid PVC Conduit.
43. PVC-A: Type A rigid PVC concrete-encased conduit.
44. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
45. RGS: See ERMCS-G.
46. RMC: See ERMCS.
47. RTRC: Reinforced thermosetting resin conduit.
48. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
49. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
50. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
51. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
52. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.

- 22. FCC: Flat conductor cable.
- 23. FPL: Power-limited fire-alarm cable.
- 24. FPLP: Power-limited fire-alarm plenum cable.
- 25. FPLR: Power-limited fire-alarm riser cable.
- 26. IGS: Integrated gas spacer cable.
- 27. ITC: Instrumentation tray cable.
- 28. ITC-ER: Instrumentation tray cable, exposed run.
- 29. MC: Metal-clad cable.
- 30. MC-HL: Metal-clad cable, hazardous location.
- 31. MI: Mineral-insulated, metal-sheathed cable.
- 32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
- 33. MV: Medium-voltage cable.
- 34. NM: Nonmetallic sheathed cable.
- 35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
- 36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
- 37. NPLF: Non-power-limited fire-alarm circuit cable.
- 38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
- 39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
- 40. NUCC: Nonmetallic underground conduit with conductors.
- 41. OFC: Conductive optical fiber general-purpose cable.
- 42. OFCG: Conductive optical fiber general-purpose cable.
- 43. OFCP: Conductive optical fiber plenum cable.
- 44. OFCR: Conductive optical fiber riser cable.
- 45. OFN: Nonconductive optical fiber general-purpose cable.
- 46. OFNG: Nonconductive optical fiber general-purpose cable.
- 47. OFNP: Nonconductive optical fiber plenum cable.
- 48. OFNR: Nonconductive optical fiber riser cable.
- 49. P: Marine shipboard cable.
- 50. PLTC: Power-limited tray cable.
- 51. PLTC-ER: Power-limited tray cable, exposed run.
- 52. PV: Photovoltaic cable.
- 53. RHH: (high heat) Thermoset rubber, heat-resistant cable.
- 54. RHW: Thermoset rubber, moisture-resistant cable.
- 55. SA: Silicone rubber cable.
- 56. SE: Service-entrance cable.
- 57. SER: Service-entrance cable, round.
- 58. SEU: Service-entrance cable, flat.
- 59. SIS: Thermoset cable for switchboard and switchgear wiring.
- 60. TBS: Thermoplastic cable with outer braid.
- 61. TC: Tray cable.
- 62. TC-ER: Tray cable, exposed run.
- 63. TC-ER-HL: Tray cable, exposed run, hazardous location.
- 64. THW: Thermoplastic, heat- and moisture-resistant cable.
- 65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
- 66. THHW: Thermoplastic, heat- and moisture-resistant cable.
- 67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
- 68. TW: Thermoplastic, moisture-resistant cable.
- 69. UF: Underground feeder and branch-circuit cable.
- 70. USE: Underground service-entrance cable.

- 71. XHH: Cross-linked polyethylene, heat-resistant cable.
- 72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

- 1. SE0: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
- 2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
- 3. SE00: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
- 4. SE00W: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
- 5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
- 6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
- 7. SJEO0: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
- 8. SJEO0W: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
- 9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
- 10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
- 11. SJ00: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
- 12. SJ00W: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
- 13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
- 14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
- 15. SJTO0: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
- 16. SJTO0W: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
- 17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
- 18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
- 19. SO0: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
- 20. SO0W: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
- 21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
- 22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

23. ST00: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. ST00W: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
 - a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.
2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
7. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.
8. Direct Buried: Installed underground without encasement in concrete or other protective material.
9. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
 - a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - f. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed

- against the entrance of scrub water at the floor level.
- j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - o. Raised-Floor Box: A floor box intended for use in raised floors.
 - p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 - r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
10. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
11. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
12. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
- a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.
13. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
14. Jacket: A continuous nonmetallic outer covering for conductors or cables.
15. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
16. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
17. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and

- switches, assembled in the field or at the factory.
18. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
 19. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
 20. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
 21. Sheath: A continuous metallic covering for conductors or cables.
 22. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
 23. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.
 24. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify [Architect] [Construction Manager] [Owner] [Tenant] no fewer than [seven] <Insert number> days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without [Architect's] [Construction Manager's] [Owner's] [Tenant's] written permission.
 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Elevators.
 - d. Fire-alarm systems.
- B. Arrange to provide temporary electrical [service] [or] [power] in accordance with requirements specified in Division 01.

1.4 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than [10] <Insert number> days after notice to proceed. Agenda topics include, but are not limited to, the following:
 - 1. Electrical installation schedule.
 - 2. Status of power system studies.
 - 3. Value analysis proposals and requests for substitution of electrical equipment.
 - 4. Utility work coordination and class of service requests.
 - 5. Commissioning activities.
 - 6. Sustainability activities[, including Measurement and Verification Plan].

1.5 SEQUENCING

- A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.6 SCHEDULING

- A. <Insert requirements for unusual scheduling coordination>.

1.7 ACTION SUBMITTALS

- A. Coordination drawings.

1.8 INFORMATIONAL SUBMITTALS

- A. Electrical installation schedule.
- B. Qualification statements.
- C. Welding certificates.
- D. Seismic-load performance certificates[and wind-load performance certificates].
- E. Delegated design drawings for structural masonry wall penetrations.

1.9 CLOSEOUT SUBMITTALS

- A. Facility EPM program binders.
- B. Operation and maintenance data.
- C. Software and firmware operational documentation.
- D. Software.

1.10 QUALITY ASSURANCE

A. Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:

1. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 014000 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than **[eight hours]** **<Insert time>**.
2. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering[, **including seismic- and wind-load modeling and analysis**].
3. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.
4. Lighting Professional Engineer: Professional engineer possessing active qualifications in accordance with Section 014000 "Quality Requirements" and the following:
 - a. Expertise in electrical engineering, lighting design, and structural requirements for exterior poles and standards.
 - b. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).
5. EPM Specialist: Recognized experts possessing the following qualifications in accordance with Section 014000 "Quality Requirements" and NFPA 70B:
 - a. Technical Competence: Person should, by education, training, and experience, be well-rounded in all aspects of electrical maintenance.
 - b. Administrative and Supervisory Skills: Person should be skilled in planning and development of long-range objectives to achieve specific results and should be able to command respect and solicit cooperation of persons involved in EPM Program development.
6. Welder: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," with training and certification in accordance with **[AWS D1.1/D1.1M]** **[and]** **[AWS D1.2/D1.2M]**.
7. ERM-C-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERM-C-S-PVC manufacturer prior to starting installation.
8. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable[**in accordance with electrical utility service provider's requirements**].
 - a. Medium-voltage cable Installer must be approved by **<Insert name of electrical utility service provider>**.
9. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks[**in accordance with electrical utility service provider's requirements**].
 - a. Medium-voltage duct Installer must be approved by **<Insert name of electrical utility service provider>**.
10. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment[**in accordance with electrical utility service provider requirements**].
 - a. Medium-voltage equipment Installer must be approved by **<Insert name of electrical utility service provider>**.

11. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.
12. EVSE Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by EVSE manufacturer prior to starting installation.
13. Generator Set Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by generator set manufacturer prior to starting installation.
14. Lightning Protection System Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present [unexpired UL-Listed Installer, UL Category Control Number OWAY, credentials] [or] [unexpired LPI Master Installer credentials] prior to starting installation.
15. Theatrical Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by theatrical lighting manufacturers prior to starting installation.
16. Exterior Athletic Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by exterior athletic lighting manufacturer prior to starting installation.
17. Power Quality Specialist: Recognized experts possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction, and able to present unexpired NICET Level 4 credentials with documented experience in power quality testing for installations similar in complexity to this Project.
18. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
19. Medium-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
20. Power-Limited Electrical Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site power-limited testing supervisor must have BICSI Registered Communications Distribution Designer certification and documented training and experience with testing power-limited equipment in accordance with NETA testing standards.
21. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing structural concrete, seismic controls, and wind-load controls.
22. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.
23. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under the NVLAP for Energy Efficient Lighting Products, and complying with applicable IES testing standards.
24. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with

IES LM-5.

B. Certifications:

1. Seismic-Load Performance Certificates: Provide special certification for designated seismic systems as indicated in Paragraph 13.2.2 "Special Certification Requirements for Designated Seismic Systems" of [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16] for all designated seismic-load systems identified on Drawings or in the Specifications.

a. Include the following information:

- 1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- 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.
- 4) Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- 5) Provide equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction[, or **experience data as permitted by**] [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16].
- 6) Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16].
- 7) Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

b. The following systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:

- 1) Equipment, accessories, and components specified in Section 111136 "Vehicle Charging Equipment."
- 2) Hangers and supports specified in Section 260529 "Hangers and Supports for Electrical Systems."
- 3) Conduits and their mounting provisions specified in Section 260533.13 "Conduits for Electrical Systems."
- 4) Boxes and their mounting provisions specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- 5) Surface raceways and their mounting provisions specified in Section 260533.23 "Surface Raceways for Electrical Systems."
- 6) Seismic restraints specified in [Section 260548 "Vibration and Seismic Controls for Electrical Systems."] [Section 260548.16 "Seismic Controls for Electrical Systems."]
- 7) Cable trays, accessories, and components specified in Section 260536 "Cable Trays for Electrical Systems."
- 8) Equipment, accessories, and components specified in Section 261116.11 "Secondary Unit Substations with Switchgear Secondary."
- 9) Equipment, accessories, and components specified in Section 261116.12 "Secondary Unit Substations with Switchboard Secondary."
- 10) Equipment, accessories, and components specified in Section 261116.13 "Secondary Unit Substations with Motor Control Center Secondary."

- 11) Equipment, accessories, and components specified in Section 261213 "Liquid-Filled, Medium-Voltage Transformers."
- 12) Equipment, accessories, and components specified in Section 261216 "Dry-Type, Medium-Voltage Transformers."
- 13) Equipment, accessories, and components specified in Section 261219 "Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers."
- 14) Equipment, accessories, and components specified in Section 261323 "Medium-Voltage Metal-Enclosed Switchgear."
- 15) Equipment, accessories, and components specified in Section 261326 "Medium-Voltage Metal-Clad Switchgear."
- 16) Equipment, accessories, and components specified in Section 261329 "Medium-Voltage Compartmentalized Switchgear."
- 17) Equipment, accessories, and components specified in Section 262213 "Low-Voltage Distribution Transformers."
- 18) Equipment, accessories, and components specified in Section 262216 "Low-Voltage Buck-Boost Transformers."
- 19) Equipment, accessories, and components specified in Section 262300 "Low-Voltage Switchgear."
- 20) Equipment, overcurrent protective devices, accessories, and components specified in Section 262313 "Paralleling Low-Voltage Switchgear."
- 21) Equipment, accessories, and components specified in Section 262413 "Switchboards."
- 22) Equipment, accessories, and components specified in Section 262416 "Panelboards."
- 23) Equipment, accessories, and components specified in Section 262416.16 "Electronically Operated Circuit-Breaker Panelboards."
- 24) Equipment, accessories, and components specified in Section 262419 "Motor-Control Centers."
- 25) Equipment, accessories, and components specified in Section 262500 "Low-Voltage Enclosed Bus Assemblies."
- 26) Cabinets, enclosures, racks, and their mounting provisions specified in Section 262716 "Electrical Cabinets and Enclosures."
- 27) Equipment, accessories, and components specified in Section 262733 "Power Distribution Units."
- 28) Equipment, accessories, and components specified in Section 262816 "Enclosed Switches and Circuit Breakers."
- 29) Equipment, accessories, and components specified in Section 262913.03 "Manual and Magnetic Motor Controllers."
- 30) Equipment, accessories, and components specified in Section 262913.06 "Soft-Start Motor Controllers."
- 31) Equipment, accessories, and components specified in Section 262923 "Variable-Frequency Motor Controllers."
- 32) Equipment, accessories, and components specified in Section 262933 "Controllers for Fire Pump Drivers."
- 33) Equipment, accessories, and components specified in Section 263100 "Photovoltaic Collectors."
- 34) Equipment, accessories, and components specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."
- 35) Equipment, accessories, and components specified in Section 263213.16 "Gas-Engine-Driven Generator Sets."
- 36) Equipment, accessories, and components specified in Section 263213.19 "Bi-Fuel-Engine-Driven Generator Sets."
- 37) Equipment, accessories, and components specified in Section 263223.13 "Horizontal-Axis Wind Turbines."
- 38) Equipment, accessories, and components specified in Section 263223.16 "Vertical-Axis Wind Turbines."
- 39) Equipment, accessories, and components specified in Section 263323.11 "Central Battery Equipment for Emergency Lighting."
- 40) Equipment, accessories, and components specified in Section 263343 "Battery Chargers."

- 41) Equipment, accessories, and components specified in Section 263353 "Static Uninterruptible Power Supply."
 - 42) Equipment, accessories, and components specified in Section 263533 "Power Factor Correction Equipment."
 - 43) Equipment, accessories, and components specified in Section 263600 "Transfer Switches."
 - 44) Luminaires, accessories, and components specified in Section 265000 "Lighting."
 - 45) Luminaires, accessories, components, and dimmer racks specified in Section 265561 "Theatrical Lighting."
 - 46) Luminaires, accessories, and components specified in Section 265568 "Athletic Field Lighting."
 - 47) <Insert additional items>.
2. Wind-Load Performance Certificates: Provide special certification for systems and components designated on Drawings or in the Specifications to be subject to high wind exposure and impact damage.
- a. Include the following information:
 - 1) Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
 - 2) Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
 - b. The following systems and components require written special certification of resistance to effects of high wind-load and impact damage by manufacturer:
 - 1) <Insert items>.

1.11 MOCKUPS

- A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:
 1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of <Insert identification of room and fabrication> by [Architect] [Owner] [Tenant] <Insert approving stakeholders> prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.
- B. 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.

1.12 FIELD CONDITIONS

- A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 26 must comply with requirements specified in Section 260011 "Facility Performance Requirements for Electrical."
- B. Service Conditions for Electrical Power Equipment: Besides conditions specified in Section 260011 "Facility Performance Requirements for Electrical," specified electrical power equipment must be suitable for operation under service conditions specified as usual service conditions in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards, except for the following:

1. <Insert equipment location>:
 - a. Exposure to significant solar radiation.
 - b. Exposure to fumes, vapors, or dust.
 - c. Exposure to explosive environments.
 - d. Ambient temperature not exceeding [104 deg F] [122 deg F] [140 deg F] <Insert temperature>.
 - e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 - f. Unusual transportation or storage conditions.
 - g. Unusual grounding resistance conditions.
 - h. Unusual space limitations.

PART 2 - PRODUCTS

~~2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT~~

~~A. Substitution requests for electrical equipment will be entertained under the following conditions:~~

- ~~1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Electrical Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution request. Submission of requests for substitutions for convenience must meet the conditions and deadline specified in Section 012500 "Substitution Procedures" to receive approval.~~
- ~~2. For electrical equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Electrical Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.~~

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 1. <Insert Project requirements>.
- B. Preinstallation Testing:
 1. <Insert Project requirements>.
- C. Evaluation and Assessment:
 1. <Insert Project requirements>.

3.2 PREPARATION

- A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical

installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
 2. Submission of specified coordination drawings.
 3. Submission of action submittals specified in Division 26.
 4. Orders placed for major electrical equipment.
 5. Arrival of major electrical equipment on-site.
 6. Preinstallation meetings specified in Division 26.
 7. Utility service outages.
 8. Utility service inspection and activation.
 9. Mockup reviews.
 10. Closing of walls and ceilings containing electrical Work.
 11. System startup, testing, and commissioning activities for major electrical equipment.
 12. System startup, testing, and commissioning activities for emergency lighting.
 13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
 15. Requests for special inspections.
 16. Requests for inspections by authorities having jurisdiction.
- B. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.
- C. Coordination Drawings for Ceiling Areas: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
 2. Structural members to which equipment, luminaires, and suspension systems will be attached.
 3. Partitions and millwork that penetrate ceiling or extend to within **12 inch** of plane of luminaires.
 4. Size and location of access panels on ceilings.
 5. Elevation, size, and route of sprinkler piping.
 6. Elevation, size, and route of plumbing piping.
 7. Elevation, size, and route of ductwork.
 8. Elevation, size, and route of cable tray.
 9. Elevation, size, and route of conduit.
 10. Elevation and size of wall-mounted and ceiling-mounted equipment.
 11. Moldings.
 12. Access panels.
 13. Sprinklers.
 14. Air inlets and outlets.
 15. Control modules.
 16. Luminaires.
 17. Communications devices.
 18. Speakers.
 19. Ceiling-mounted projectors.
 20. Security devices.
 21. Fire-alarm devices.
 22. Indicate clear dimensions for maintenance access in front of equipment.

23. Indicate dimensions of fully-open access doors.
- D. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Elevation, size, and route of cable trays.
 2. Relationships between components and adjacent structural, electrical, and mechanical elements.
 3. Vertical and horizontal offsets and transitions.
 4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
 5. Elevation of ceilings and size of ceiling tiles.
 6. Locations of access panels on ceilings.
 7. Locations where cable tray crosses or parallels sprinkler piping.
 8. Locations where cable tray crosses plumbing piping.
 9. Locations where cable tray crosses or parallels ductwork.
 10. Locations of access panels on ductwork.
 11. Locations where cable tray crosses conduit.
 12. Items blocking access around cable trays, including the following:
 - a. Light fixtures.
 - b. Speakers.
 - c. Fire-alarm devices.
 - d. Power outlets.
 - e. Wall-mounted equipment.
 - f. Equipment racks.
 - g. Furniture.
 - h. Door swings.
 - i. Building features.
 13. Indicate clear dimension between cable tray and walls or obstructions that are closer than **10 ft**.
 14. Highlight locations where cable tray is greater than **3 ft** above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.
- E. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- F. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
 2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
 3. Clearances for access above and to the side of enclosed bus assemblies.
 4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
 5. Support locations, type of support, and weight on each support.
 6. Location of adjacent construction elements including luminaires, HVAC and plumbing equipment, fire sprinklers and piping,

signal and control devices, and other equipment.

G. Coordination Drawings for Large Equipment Indoor Installations:

1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
 - b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
 - c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[, **busways**,] [**and seismic bracing**].
 - b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
 - c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

H. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
 - b. Indicate clear dimensions for fence gates and wall openings.
 - c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
 - d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
 - e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[, **busways**,] [**and seismic bracing**].
 - f. Dimensioned working clearances and dedicated areas around electrical equipment.

I. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

J. Protection of In-Place Conditions:

1. <Insert Project requirements>.

3.3 DELEGATED DESIGN OF STRUCTURAL PENETRATIONS

- A. Engage qualified structural professional engineer to design penetrations of structural masonry walls.
- B. Delegated Design Drawings for Structural Masonry Wall Penetrations: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by elevations, sections, and other details, drawn to scale, signed and sealed by a qualified structural professional engineer, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Location and dimensions of structural members supporting wall.
 - 2. Location and dimensions of columns near penetrations.
 - 3. Location and dimension of headers and lintels.
 - 4. Doors and windows near penetrations.
 - 5. Location and dimensions of penetrating cuts.
 - 6. Sprinkler piping and sleeves.
 - 7. Plumbing piping and sleeves.
 - 8. Ductwork and sleeves.
 - 9. Cable tray and sleeves.
 - 10. Conduit and sleeves.
 - 11. Firestopping assemblies for rated penetrations.
 - 12. Structural supports for piping, ductwork, and conduit on both sides of wall.
- C. Delegated Design Criteria: [**As depicted on Drawings.**]
 - 1. <Insert delegated design criteria>.

3.4 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.5 SYSTEM STARTUP

- A. Commissioning Activities:
 - 1. <Insert requirements>.

3.6 FIELD QUALITY CONTROL

- A. Adminstrant for Medium-Voltage Electrical Tests and Inspections:
 - 1. [Owner] [Tenant] will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections [**with assistance of factory-authorized service representative**].

B. Administrant for Low-Voltage Electrical Tests and Inspections:

1. [Owner] [Tenant] will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

C. Administrant for Power-Limited Electrical Tests and Inspections:

1. [Owner] [Tenant] will engage qualified power-limited electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified power-limited electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

D. Administrant for Structural Tests and Inspections:

1. [Owner] [Tenant] will engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

E. Administrant for Field Tests and Inspections of Lighting Installations:

1. [Owner] [Tenant] will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[**with assistance of factory-authorized service representative**].

3.7 CLEANING

A. Waste Management:

1. <Insert requirements for electrical and electronics waste disposal>.

3.8 CLOSEOUT ACTIVITIES

A. Development of Facility EPM Program

1. Facility EPM Program must be developed by qualified EPM specialist.
2. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.

- a. Renovation Projects:
 - 1) Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
 - 2) Obtain copies of existing operation and maintenance data and existing Facility EPM Program information from Owner.
 - 3) Facility EPM Program analysis should identify existing equipment that does not have available operation and maintenance data, and should explain the Owner's risks because this equipment is not included in Facility EPM Program.
 - 4) Data for existing equipment outside scope of Project may be inserted in Facility EPM Program Binders without analysis.
 - 5) Data for existing equipment impacted by scope of Project should be analyzed and documented similar to Project's new equipment data as much as possible.
3. Compile operation and maintenance data from Facility EPM Program analysis and submit **[updated]** Facility EPM Program Binders.
4. Organization of Facility EPM Program Binders:
 - a. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EPM Program development.
 - b. Referenced Standards: Content must comply with recommendations in NFPA 70B.
 - c. General Characteristics:
 - 1) Volume 1 - Introduction:
 - a) Summarize how Facility EPM Program Analysis was performed, how data were collected, and how volumes are organized.
 - b) Describe Facility EPM Program and provide recommended policies and procedures for implementing the program and keeping it current.
 - c) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EPM Program.
 - 2) Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:
 - a) Include training requirements for employees and contractors.
 - b) Include list of known facility hazards impacting IT&R activities.
 - c) Include approval and permitting procedures for IT&R activities.
 - d) Include incident emergency response procedures.
 - e) Include emergency shutdown procedures.
 - f) Include electrical disaster recovery procedures.
 - 3) Volume 3 - Operating Procedures for Electrical Equipment and Controls:
 - a) Include copies of demonstration and training videos.
 - b) **<Insert requirements>**.
 - 4) Volume 4 - Facility Diagrams and Schedules:
 - a) Include single-line diagrams.

- b) Include grounding and bonding diagrams.
 - c) Include essential wiring diagrams.
 - d) Include system communications diagrams (WAN, LAN, Wi-Fi, ERCES, MNS, etc.)
 - e) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
 - f) Include records of switchgear, switchboard, and panelboard schedules.
 - g) Include time-current curves for overcurrent protective devices.
 - h) Include list of load-current and overload-relay heaters with related motor nameplate data.
- 5) Volume 5 - Inventory of Facility Equipment Using Electrical Power:
- a) Include simplified floor plans showing equipment locations.
 - b) Identify critical equipment (electrical or otherwise).
 - c) Include identifying designations and nameplate data.
 - d) Include warranty and maintenance contract information.
- 6) Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:
- a) Include schedules of maintenance material items recommended to be stored at facility.
 - b) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
 - c) Include calibration and servicing data for each item.
- 7) Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:
- a) Include tables showing frequency of activities for each item.
 - b) Include annual schedule with activities mapped to specific days of the year.
 - c) Include exterior pole inspection and repair procedures.
- 8) Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:
- a) <Insert requirements>.
- 9) Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:
- a) <Insert requirements>.
- 10) Volume 10 - Spare Parts List:
- a) Include list of all parts required to perform IT&R procedures.
 - b) Identify quantities of which parts are recommended to be stored on-site.
 - c) Include source contact information and budget cost for each item.
- 11) Volume 11 - Construction Project Closeout Record Documentation:
- a) Include records of power system studies and photometric studies.
 - b) Include records of risk assessment studies.
 - c) Include records of electrical system startup and commissioning activities.
 - d) Include records of baseline inspections and tests.
 - e) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.

- f) Include records of baseline settings for adjustable equipment and devices.
- 5. Format of Facility EPM Program Binders Submittal:
 - a. Complete Set: On **[approved online or cloud solution] [and] [USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement]**.
 - b. Volumes 2 and 8: Reproducible hardcopy on archival quality, **28 lb**, acid-free, bond paper.
- B. Operation and Maintenance Data: Prepare and submit the following:
 - 1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:
 - a. **<Insert system, equipment, or device>**.
 - 2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.
 - g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
 - h. Manufacturer's instructions for setting field-adjustable components.
 - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
 - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
 - k. Exterior pole inspection and repair procedures.
 - l. Include copies of demonstration and training videos.
- C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation **[in Facility EPM Program Binders]**, including the following:
 - 1. Software operating and upgrade manuals.
 - 2. Names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Testing and adjusting of panic and emergency power features.
 - 6. For lighting controls, include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.
- D. Software:
 - 1. Program Software Backup: Provide **[username and password for approved online or cloud solution] [and] [USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement]**.

2. Provide to Owner upgrades and unrestricted licenses[**for Government use**] for installed and backup software, including operating systems and programming tools required for operation and maintenance.
- E. Demonstration: **[With assistance from factory-authorized service representatives, demonstrate]** **[Demonstrate]** to Owner's maintenance and clerical personnel[**and building occupants**] how to operate the following systems and equipment:
1. Lighting control devices specified in Section 260923 "Lighting Control Devices."
 2. Lighting control systems specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
 3. Lighting control systems specified in Section 260943.23 "Relay-Based Lighting Controls."
 4. Electronic metering and billing software specified in Section 262713 "Electricity Metering."
 5. **<Insert system or equipment>.**
- F. Training: **[With assistance from factory-authorized service representatives, train]** **[Train]** Owner's maintenance personnel on the following topics:
1. How to implement **[updated]** Facility EPM Program.
 2. How to adjust, operate, and maintain equipment specified in Section 111136 "Vehicle Charging Equipment."
 3. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in study report specified in Section 260573.16 "Coordination Studies."
 4. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in study report specified in Section 260573.19 "Arc-Flash Hazard Analysis."
 5. How to adjust, operate, and maintain systems specified in Section 260913 "Electrical Power Monitoring."
 6. How to adjust, operate, and maintain devices specified in Section 260923 "Lighting Control Devices."
 7. How to adjust, operate, and maintain hardware and software specified in Section 260936 "Modular Dimming Controls." **[Laptop computer must be used in training.]**
 8. How to adjust, operate, and maintain hardware and software specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
 9. How to adjust, operate, and maintain hardware and software specified in Section 260943.23 "Relay-Based Lighting Controls."
 10. How to adjust, operate, and maintain equipment specified in Section 261116.11 "Secondary Unit Substations with Switchgear Secondary."
 11. How to adjust, operate, and maintain equipment specified in Section 261116.12 "Secondary Unit Substations with Switchboard Secondary."
 12. How to adjust, operate, and maintain equipment specified in Section 261116.13 "Secondary Unit Substations with Motor Control Center Secondary."
 13. How to adjust, operate, and maintain equipment specified in Section 261213 "Liquid-Filled, Medium-Voltage Transformers."
 14. How to adjust, operate, and maintain equipment specified in Section 261216 "Dry-Type, Medium-Voltage Transformers."
 15. How to adjust, operate, and maintain equipment specified in Section 261219 "Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers."
 16. How to adjust, operate, and maintain equipment specified in Section 261323 "Medium-Voltage Metal-Enclosed Switchgear."
 17. How to adjust, operate, and maintain equipment specified in Section 261326 "Medium-Voltage Metal-Clad Switchgear."
 18. How to adjust, operate, and maintain equipment specified in Section 261329 "Medium-Voltage Compartmentalized Switchgear."
 19. How to adjust, operate, and maintain equipment specified in Section 262300 "Low-Voltage Switchgear."
 20. How to adjust, operate, and maintain equipment specified in Section 262313 "Paralleling Low-Voltage Switchgear."
 21. How to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories[**and to use and reprogram microprocessor-based trip, monitoring, and communication units**] specified in Section 262413

- "Switchboards."
22. How to adjust, operate, and maintain control modules specified in Section 262416.16 "Electronically Operated Circuit-Breaker Panelboards."
 23. How to adjust, operate, and maintain enclosed controllers specified in Section 262419 "Motor-Control Centers."
 24. How to adjust, operate, and maintain hardware and software specified in Section 262713 "Electricity Metering."
 25. How to adjust, operate, and maintain equipment specified in Section 262733 "Power Distribution Units."
 26. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."
 27. How to adjust, operate, and maintain equipment specified in Section 262913.06 "Soft-Start Motor Controllers."
 28. How to adjust, operate, and maintain equipment specified in Section 262923 "Variable-Frequency Motor Controllers."
 29. How to adjust, operate, and maintain controllers[, **remote alarm panels**] [, **low-suction-shutdown panels**] [, **and to use and reprogram microprocessor-based controls within this equipment**] specified in Section 262933 "Controllers for Fire Pump Drivers."
 30. How to adjust, operate, and maintain equipment specified in Section 263100 "Photovoltaic Collectors."
 31. How to adjust, operate, and maintain equipment specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."
 32. How to adjust, operate, and maintain equipment specified in Section 263213.16 "Gas-Engine-Driven Generator Sets."
 33. How to adjust, operate, and maintain equipment specified in Section 263213.19 "Bi-Fuel-Engine-Driven Generator Sets."
 34. How to adjust, operate, and maintain equipment specified in Section 263323.11 "Central Battery Equipment for Emergency Lighting."
 35. How to adjust, operate, and maintain equipment specified in Section 263343 "Battery Chargers."
 36. How to adjust, operate, and maintain equipment specified in Section 263353 "Static Uninterruptible Power Supply."
 37. How to adjust, operate, and maintain equipment specified in Section 263533 "Power Factor Correction Equipment."
 38. How to adjust, operate, and maintain transfer switches and related equipment, including ground-fault protection system, specified in Section 263600 "Transfer Switches."
 39. How to adjust, operate, and maintain devices specified in Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits."
 40. How to adjust, operate, and maintain stage lighting equipment specified in Section 265561 "Theatrical Lighting."
 41. How to adjust, operate, and maintain luminaires[**and photoelectric controls**] specified in Section 265617 "Fluorescent Exterior Lighting."
 42. How to adjust, operate, and maintain luminaires[**and photoelectric controls**] specified in Section 265619 "LED Exterior Lighting."
 43. How to adjust, operate, and maintain luminaires[**and photoelectric controls**] specified in Section 265621 "HID Exterior Lighting."
 44. <Insert system or equipment>.

END OF SECTION 260010

SECTION 260011 - FACILITY PERFORMANCE REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field conditions and other facility performance requirements applicable to Work specified in Division 26.

1.2 FIELD CONDITIONS

A. Seismic Hazard Design Loads:

1. Unless otherwise indicated on Contract Documents, specified Work must withstand seismic hazard design loads determined in accordance with requirements specified in this Section, adjusted for installed elevation above or below grade.
 - a. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic hazard design loads[**and unit must be fully operational after seismic event**]."
2. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [ASCE/SEI 7-05] [ASCE/SEI 7-10 including supplement No. 1] [ASCE/SEI 7-16] <Insert ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction>. Where "ASCE/SEI 7" is used throughout this Section, it must be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
 - a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors.
 - c. Building Occupancy Category: [I] [II] [III] [IV].
 - d. Building Risk Category: [I] [II] [III] [IV].
 - e. Building Site Classification: [A] [B] [C] [D] [E] [F].
3. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise indicated.
 - a. Horizontal Seismic Design Force F_p : Value must be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) Spectral Acceleration (SDS): <Insert value>. Value applies to all components on Project.
 - 2) Component Amplification Factor (a_p): See Drawing Schedule for each component.
 - 3) Component Importance Factor (I_p): See Drawing Schedule for each component.
 - 4) Component Operating Weight (W_p): For each component. Obtain by Delegated Design Contractor from each component submittal.
 - 5) Component Response Modification Factor (R_p): See Drawing Schedule for each component.
 - 6) Height in Structure of Point of Attachment of Component for Base (z): Determine from Project Drawings for

- each component by Delegated Design Contractor. For items at or below the base, "z" must be taken as zero.
- 7) Average Roof Height of Structure for Base (h): Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
 - c. Seismic Relative Displacement (Dpl): Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) Relative Seismic Displacement that Each Component Must Be Designed to Accommodate (Dp): Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
 - 2) Structure Importance Factor (Ie): **<Insert value>**. Value applies to all components on Project.
 - 3) Deflection at Building Level x of Structure A (xA): See Drawing Schedule for each component.
 - 4) Deflection at Building Level y of Structure A (yA): See Drawing Schedule for each component.
 - 5) Deflection at Building Level y of Structure B (yB): See Drawing Schedule for each component.
 - 6) Height of Level x to Which Upper Connection Point Is Attached (hx): Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 7) Height of Level y to Which Upper Connection Point Is Attached (hy): Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 8) Allowable Story Drift for Structure A (aA): See Drawing Schedule for each component.
 - 9) Allowable Story Drift for Structure B (aB): See Drawing Schedule for each component.
 - 10) Story Height Used in the Definition of the Allowable Drift a (hsx): See Drawings Schedules for each component.
 - d. Component Fundamental Period (Tp): Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
 - 1) Component Operating Weight (Wp): Determined by Contractor from Project Drawings and manufacturer's data.
 - 2) Gravitational Acceleration (g): **[32.17 ft./s²]** **<Insert option>**.
 - 3) Combined Stiffness of the Component, Supports, and Attachments (Kp): Determined by delegated design seismic engineer. **<Insert value>**.
4. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise indicated.
 - a. Horizontal Seismic Design Force (Fp): Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) Spectral Acceleration (SDS): **<Insert value>**. Value applies to all components on Project.
 - 2) Component Amplification Factor (ap): See Drawing Schedule for each component.
 - 3) Component Importance Factor (Ip): See Drawing Schedule for each component.
 - 4) Component Operating Weight (Wp): For each component. Obtain by Delegated Design Contractor from equipment submittal.
 - 5) Component Response Modification Factor (Rp): See Drawing Schedule for each component.
 - 6) Height in Structure of Point of Attachment of Component for Base (z): Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" must be taken as zero.
 - 7) Average Roof Height of Structure for Base (h): Determine from Project Drawings by Delegated Design

Contractor.

- b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
 - c. Seismic Relative Displacement (D_p): Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) Relative Seismic Displacement that Each Component Must Be Designed to Accommodate (D_p): Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
 - 2) Structure Importance Factor (I_e): <Insert value>. Value applies to all components on Project.
 - 3) Deflection at Building Level x of Structure A (x_A): See Drawing Schedule for each component.
 - 4) Deflection at Building Level y of Structure A (y_A): See Drawing Schedule for each component.
 - 5) Deflection at Building Level y of Structure B (y_B): See Drawing Schedule for each component.
 - 6) Height of Level x to Which Upper Connection Point Is Attached (h_x): Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 7) Height of Level y to Which Upper Connection Point Is Attached (h_y): Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 8) Allowable Story Drift for Structure A (α_A): See Drawing Schedule for each component.
 - 9) Allowable Story Drift for Structure B (α_B): See Drawing Schedule for each component.
 - 10) Story Height Used in the Definition of the Allowable Drift α (h_{sx}): See Drawing Schedule for each component.
5. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise indicated.
- a. Horizontal Seismic Design Force (F_p): Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:
 - 1) Spectral Acceleration (SDS): <Insert value>. Value applies to all components on Project.
 - 2) Component Amplification Factor (a_p): See Drawing Schedule for each component.
 - 3) Component Importance Factor (I_p): See Drawing Schedule for each component.
 - 4) Component Operating Weight (W_p): Obtain by Delegated Design Contractor for each component from component submittal.
 - 5) Component Response Modification Factor (R_p): See Drawing Schedule for each component.
 - 6) Height in Structure of Point of Attachment of Component for Base (z): Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" must be taken as zero.
 - 7) Average Roof Height of Structure for Base (h): Determine by Delegated Design Contractor from Project Drawings.
 - b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
 - c. Seismic Relative Displacement (D_p): Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) Deflection at Building Level x of Structure A (x_A): See Drawing Schedule for each component.
 - 2) Deflection at Building Level y of Structure A (y_A): See Drawing Schedule for each component.
 - 3) Deflection at Building Level y of Structure B (y_B): See Drawing Schedule for each component.
 - 4) Height of Level x to Which Upper Connection Point Is Attached (h_x): Determine for each component by

- Delegated Design Contractor from Project Drawings and manufacturer's data.
- 5) Height of Level y to Which Upper Connection Point Is Attached (h_y): Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
 - 6) Allowable Story Drift for Structure A (ΔA): See Drawing Schedule for each component.
 - 7) Allowable Story Drift for Structure B (ΔB): See Drawing Schedule for each component.
 - 8) Story Height Used in the Definition of the Allowable Drift Δ (h_{sx}): See Drawing Schedule for each component.

B. Wind Hazard Design Loads:

1. Perform calculations to obtain force information necessary to properly select wind-load restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [ASCE/SEI 7-05] [ASCE/SEI 7-10] [ASCE/SEI 7-16] <Insert ASCE/SEI 7 edition or other wind-load calculation method required by authorities having jurisdiction>. Where "ASCE/SEI 7" is used throughout this Section, it must be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise indicated.
 - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with seismic-load calculations for equipment requiring both seismic- and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section.
2. Design wind pressure "p" for external sidewall-mounted equipment must be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:
 - a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" less than 60 ft.
 - d. PART 4: Buildings with "h" greater than 60 ft. and less than 160 ft..
 - e. PART 5: Open Buildings.
3. Design wind pressure "p" for rooftop equipment must be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Risk Category: [I] [II] [III] [IV] [V].
 - b. Mean Roof Height (h): <Insert value>.
 - c. Basic Wind Speed (V): <Insert value>.
 - d. Wind Directionality Factor (K_d): <Insert factor>.
 - e. Exposure Category: [B] [C] [D].
 - f. Topographic Factor (K_{zt}): <Insert factor>.
 - g. Ground Elevation Factor (K_e): <Insert factor>.
 - h. Velocity Pressure Exposure Coefficient (Evaluated at Height z) (K_z): <Insert coefficient>.
 - i. Velocity Pressure Exposure Coefficient (Evaluated at Height h) (K_h): <Insert coefficient>.
 - j. Velocity Pressure at Height z (q_z): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - k. Velocity Pressure at Height h (q_h): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - 1) Gust-Effect Factor (G): [0.85] <Insert factor>.
 - 2) Enclosure Classification: <Insert classification>.

- 3) Internal Pressure Coefficient (GCpi): **<Insert coefficient>**.
4. Design wind pressure "p" for external sidewall-mounted equipment must be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations according to one of the following, as appropriate:
- PART 1: Low-Rise Buildings.
 - PART 2: Low-Rise Buildings (Simplified).
 - PART 3: Buildings with "h" greater than **60 ft.**
 - PART 4: Buildings with "h" less than **160 ft.**
 - PART 5: Open Buildings.
5. Design wind pressure "p" for rooftop equipment must be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
- Risk Category: [I] [II] [III] [IV] [V].
 - Mean Roof Height (h): **<Insert value>**.
 - Basic Wind Speed (V): **<Insert value>**.
 - Wind Directionality Factor (Kd): **<Insert factor>**.
 - Exposure Category: [B] [C] [D].
 - Topographic Factor (Kzt): **<Insert factor>**.
 - Velocity Pressure Exposure Coefficient (Evaluated at Height z) (Kz): **<Insert coefficient>**.
 - Velocity Pressure Exposure Coefficient (Evaluated at Height h) (Kh): **<Insert coefficient>**.
 - Velocity Pressure at Height z (qz): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - Velocity Pressure at Height h (qh): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
 - Gust-Effect Factor (G): **[0.85] <Insert factor>**.
 - Enclosure Classification: **<Insert classification>**.
 - Internal Pressure Coefficient (GCpi): **<Insert coefficient>**.
6. Design wind-load "F" for rooftop equipment and external sidewall-mounted equipment must be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
- Importance Factor (I): **<Insert factor>**.
 - Mean Roof Height (h): **<Insert value>**.
 - Basic Wind Speed (V): **<Insert value>**.
 - Wind Directionality Factor (Kd): **<Insert factor>**.
 - Exposure Category: [B] [C] [D].
 - Topographic Factor (Kzt): **<Insert factor>**.
 - Velocity Pressure Exposure Coefficient (Evaluated at Height z) (Kz): **<Insert coefficient>**.
 - Velocity Pressure Exposure Coefficient (Evaluated at Height h) (Kh): **<Insert coefficient>**.
 - Velocity Pressure at Height z (qz): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
 - Velocity Pressure at Roof Height h (qh): Value is calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
 - Gust-Effect Factor (G): **[0.85] <Insert factor>**.
 - Internal Pressure Coefficient (GCpi): **<Insert coefficient>**.
 - External Pressure Coefficient (GCp): **<Insert coefficient>**.
 - Force Coefficient (CF): Value is determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures

- o. 6-21 through 6-23 or other source approved by authorities having jurisdiction.
Projected Area Normal to the Wind (Af): Except where Cf is specified for the actual surface area. Value is determined by delegated wind-load design Contractor from equipment submittal or manufacturer.
- C. Altitude:
 - 1. Sea level to [1000 ft.] <Insert elevation>.
- D. Ambient Temperature:
 - 1. <Insert requirements>.
- E. Temperature Variation: Allow for thermal movements from the following differential temperatures:
 - 1. Ambient Temperature Differential: [120 deg F] <Insert temperature variation>.
 - 2. Material Surface Temperature Differential: [180 deg F] <Insert temperature variation>.
 - 3. Ground Surface Temperature Differential to 10 ft. Depth: <Insert temperature variation>.
- F. Ground Water:
 - 1. Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
 - 2. Assume ground-water level is [36 inch] <Insert dimension> below ground surface unless a higher water table is indicated on Drawings.
- G. Acoustical Performance Conditions:
 - 1. <Insert requirements>.
- H. Hazardous Material Environmental Conditions:
 - 1. <Insert requirements>.
- I. Corrosive Environmental Conditions:
 - 1. <Insert requirements>.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 260011

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Copper building wire.~~
- ~~2. Aluminum building wire.~~
- ~~3.1. Nonmetallic underground conduit with conductors, Type NUCC.~~
- ~~4. Metal-clad cable, Type MC.~~
- ~~5. Armored cable, Type AC.~~
- ~~6. Photovoltaic cable, Type PV.~~
- ~~7. Mineral-insulated cable, Type MI.~~
- ~~8. Tray cable, Type TC.~~
- ~~9. Fire-alarm wire and cable.~~
- ~~10. Connectors and splices.~~

B. Related Requirements:

- ~~1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
- ~~2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.~~
- ~~3. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.~~
- ~~4. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.~~
- ~~5. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.~~
- ~~6. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Aluminum building wire.
3. Nonmetallic underground conduit with conductors, Type NUCC.
4. Metal-clad cable, Type MC.
5. Armored cable, Type AC.
6. Photovoltaic cable, Type PV.
7. Mineral-insulated cable, Type MI.
8. Tray cable, Type TC.
9. Fire-alarm wire and cable.

10. Connectors and splices.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.
4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS, TYPE NUCC

A. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth wall raceway with a circular cross section.

B. Applicable Standards:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 1990.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper:
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

- C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits: **[Copper]** **[Aluminum]**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors in raceway]** **[Type USE, single conductor in raceway]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Multiconductor cable, Type SE]**.
- B. Exposed Feeders: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: **[Type THHN/THWN-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors in raceway]** **[Underground feeder cable, Type UF]**.
- E. Feeders Installed below Raised Flooring: **[Type THHN/THWN-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]**.
- F. Feeders in Cable Tray: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors larger than No. 1/0 AWG]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- G. Exposed Branch Circuits, Including in Crawlspace: **[Type THHN/THWN-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: **[Type THHN/THWN-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors in raceway]** **[Underground branch-circuit cable, Type UF]**.
- J. Branch Circuits Installed below Raised Flooring: **[Type THHN/THWN-2, single conductors in raceway]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]**.
- K. Branch Circuits in Cable Tray: **[Type THHN/THWN-2, single conductors in raceway]** **[Type XHHW-2, single conductors larger than No. 1/0 AWG]** **[Armored cable, Type AC]** **[Metal-clad cable, Type MC]** **[Mineral-insulated, metal-sheathed cable, Type MI]** **[Nonmetallic-sheathed cable, Type NM]**.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.
- M. ASD Output Circuits: **[Type XHHW-2 in metal conduit]** **[Type TC-ER cable with braided shield]** **[Type TC-ER cable with dual tape shield]**.

- N. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.
- O. PV Circuits, Type PV: For PV source circuits rated at ~~600~~ ~~1000~~ ~~2000~~ V.

3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

~~3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE~~

- ~~A. Comply with NFPA 72.~~
- ~~B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."~~
 - ~~1. Install plenum cable in environmental airspaces, including plenum ceilings.~~
 - ~~2. Fire alarm circuits and equipment control wiring associated with fire alarm system must be installed in a dedicated pathway system.~~
 - ~~a. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with fire alarm system, may not contain any other wire or cable.~~
 - ~~3. Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is **[not]** permitted.~~
 - ~~4. Signaling Line Circuits: Power-limited fire alarm cables **[may]** **[must not]** be installed in the same cable or pathway as signaling line circuits.~~
- ~~C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.~~

- D. ~~Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.~~
- E. ~~Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm-circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.~~
- F. ~~Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.~~
- G. ~~Wiring to Remote Alarm Transmitting Device: **1 inch** conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.~~

3.53.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material [**and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors**].
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least [**6 inch**] [**12 inch**] of slack.
- D. Comply with requirements in [**Section 284621.11 "Addressable Fire-Alarm Systems"**] [**Section 284621.13 "Conventional Fire-Alarm Systems"**] for connecting, terminating, and identifying wires and cables.

3.63.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.73.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.83.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.93.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test **[service entrance and feeder conductors] [and] [conductors]** feeding the following critical equipment and services for compliance with requirements:
 - a. **<Insert, in separate subparagraphs, critical equipment and services to be tested>.**
3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Grounding and bonding conductors.~~
- ~~2. Grounding and bonding clamps.~~
- ~~3. Grounding and bonding bushings.~~
- ~~4. Grounding and bonding hubs.~~
- ~~5. Grounding and bonding connectors.~~
- 6.1. Intersystem bonding bridge grounding connector.
- ~~7. Grounding and bonding busbars.~~
- ~~8. Signal reference grids.~~
- ~~9. Grounding (earthing) electrodes.~~
- ~~10. Grounding electrode enclosures.~~

B. Related Requirements:

- ~~1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
- ~~2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic load, wind load, acoustical, and other field conditions applicable to Work specified in this Section.~~
- ~~3. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.~~
- ~~4. Section 270528 "Pathways for Communications Systems" specifies additional requirements for grounding and bonding of communications raceways, boxes, and cable trays.~~
- ~~5. Section 271100 "Communications Equipment Room Fittings" specifies additional requirements for grounding and bonding of communications equipment.~~

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Product Data:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Environmental Product Declaration: For each product.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Third-Party Certifications: For each product.
8. Third-Party Certified Life Cycle Assessment: For each product.

9. Product Data: For each conductor and cable indicating lead content.
- C. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:
 1. Grounding electrode access enclosures.
 2. Grounding electrodes.
 3. Grounding arrangements and connections for separately derived systems.
 4. <Insert items>.
- D. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:
 - 1) Grounding electrode access enclosures.
 - 2) Grounding electrodes.
 - 3) Grounding arrangements and connections for separately derived systems.
 - 4) <Insert items>.
 - b. Instructions for periodic testing and inspection of grounding features at [test wells] [ring electrodes] [grounding connections for separately derived systems] <Insert locations> based on [NETA MTS] [NFPA 70B] <Insert reference>.
 - 1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

PART 2 - PRODUCTS

~~2.1 GROUNDING AND BONDING CONDUCTORS~~

~~A. Equipment Grounding Conductor:~~

- ~~1. General Characteristics: 600 V, [THHN/THWN-2] [or] [THWN-2], [copper] [or] [tinned-copper] wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."~~

~~B. Isolated Equipment Grounding Conductor:~~

- ~~1. General Characteristics: 600 V, [THHN/THWN-2] [or] [THWN-2], [copper] [or] [tinned-copper] wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."~~

2.2 — GROUNDING AND BONDING CLAMPS

- A. — Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
- B. — Source Limitations: Obtain products from single manufacturer.
- C. — Performance Criteria:
 - 1. — Regulatory Requirements:
 - a. — Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. — Listing Criteria:
 - a. — Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. — Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - 3. — Sustainability Characteristics:
 - a. — Lead Content: Less than 300 parts per million.

2.3 — GROUNDING AND BONDING BUSHINGS

- A. — Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. — Source Limitations: Obtain products from single manufacturer.
- C. — Performance Criteria:
 - 1. — Regulatory Requirements:
 - a. — Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. — Listing Criteria:
 - a. — Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

2.4 — GROUNDING AND BONDING HUBS

- A. — Description: Hubs with certified grounding or bonding locknut.
- B. — Source Limitations: Obtain products from single manufacturer.

C. ~~Performance Criteria:~~

1. ~~Regulatory Requirements:~~

- a. ~~Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~

2. ~~Listing Criteria:~~

- a. ~~Grounding and Bonding Equipment: UL CCN KDER; including UL 467.~~

2.5 ~~GROUNDING AND BONDING CONNECTORS~~

A. ~~Source Limitations: Obtain products from single manufacturer.~~

B. ~~Performance Criteria:~~

1. ~~Regulatory Requirements:~~

- a. ~~Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~

2. ~~Listing Criteria:~~

- a. ~~Grounding and Bonding Equipment: UL CCN KDER; including UL 467.~~
b. ~~Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.~~

2.6 ~~INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS~~

A. ~~Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.~~

B. ~~Performance Criteria:~~

1. ~~Regulatory Requirements:~~

- a. ~~Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~

2. ~~Listing Criteria:~~

- a. ~~Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.~~

2.7 ~~GROUNDING AND BONDING BUSBARS~~

A. ~~Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.~~

B.——Source Limitations: Obtain products from single manufacturer.

C.——Performance Criteria:

1.——Regulatory Requirements:

a.——Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.——Listing Criteria:

a.——Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

3.——Sustainability Characteristics:

a.——Lead Content: Less than 300 parts per million.

2.8——SIGNAL REFERENCE GRIDS

A.——Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

B.——Source Limitations: Obtain products from single manufacturer.

C.——Performance Criteria:

1.——Regulatory Requirements:

a.——Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.——Listing Criteria:

a.——Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

2.9——GROUNDING (EARTHING) ELECTRODES

A.——Source Limitations: Obtain products from single manufacturer.

B.——Performance Criteria:

1.——Regulatory Requirements:

a.——Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.——Listing Criteria:

~~a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.~~

~~2.10 GROUNDING ELECTRODE ENCLOSURES~~

~~A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.~~

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:
 - 1. Provide solid conductor for [8 AWG] <Insert wire size> and smaller, and stranded conductors for [6 AWG] <Insert wire size> and larger unless otherwise indicated.
 - 2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
 - 3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
 - 7. Underground Grounding Conductors: Install bare [tinned] copper conductor, [2/0 AWG] <Insert wire size> minimum.
- B. Grounding and Bonding Connectors:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.
- D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.
 - a. Install [8 AWG] [6 AWG] <Insert wire size from fault calculation> bonding conductors below grade in a grid pattern on 2 ft centers. Bond grid conductors with exothermic welds where they cross each other.
 - b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
 - c. Bond each metal fence post and gate post to at least two grid conductors.
 - d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
 - e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:
 - a. Tape mesh, 2 inch by 16 mil solid copper, [12 inch] [24 inch] spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

- A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.4 INSTALLATION OF GROUNDING AND BONDING

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 1. Grounding and Bonding Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - b. Underground Grounding Conductors:
 - 1) Bury at least 30 inch below grade.
 - 2) Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
 2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

- a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned] bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Grounding and Bonding Busbars:
- a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
 - b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.
4. Electrodes:
- a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.

- b. For grounding electrode system, install at least [three] <Insert number> rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
 - d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each [steel column] [indicated item], extending around perimeter of [building] [area or item indicated].
 - 1) Install tinned-copper conductor not less than [2/0 AWG] <Insert wire size> for ring electrode and for taps to building steel.
 - 2) Bury ring electrode not less than [24 inch] <Insert dimension> from building's foundation.
 - e. Concrete-Encased Electrode (Ufer Ground):
 - 1) Fabricate in accordance with NFPA 70; use minimum of [20 ft] <Insert dimension> of bare copper conductor not smaller than [4 AWG] <Insert wire size>.
 - a) If concrete foundation is less than [20 ft] <Insert dimension> long, coil excess conductor within base of foundation.
 - b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
 - 2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.
5. Grounding at Service:
- a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
6. Grounding Separately Derived Systems:
- a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.
7. Grounding Underground Distribution System Components:
- a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with

- waterproof, nonshrink grout.
- d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
 - e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than **6 inch** from foundation.
8. Equipment Grounding and Bonding:
- a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
 - c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
 - d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.
 - h. Metallic Fences: Comply with requirements of IEEE C2.
 - 1) Grounding Conductor: Bare [, **tinned**] copper, not less than **[8 AWG]** <Insert wire size>.
 - 2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
 - 3) Barbed Wire: Strands must be bonded to grounding conductor.

9. Fence Grounding:

- a. Grounding Method: At each grounding location, drive grounding rod vertically until top is **6 inch** below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.
- b. Fences greater than **100 ft** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of **[1500 ft]** <Insert lesser distance if grounding resistance is high>.
- c. Fences within **100 ft** of Buildings, Structures, Walkways, and Roadways: Ground fence at maximum intervals of **[750 ft]** <Insert lesser distance if grounding resistance is high>.
 - 1) Gates and Other Fence Openings: Ground fence on each side of opening.
 - a) Bond metal gates to gate posts by connecting bonding jumper between gate post and gate frame.
 - b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least **18 inch** below finished grade.
- d. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of power line crossing and at maximum distance of **150 ft** on each side of crossing.
- e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 INSTALLATION OF GROUNDING AND BONDING FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Ring Electrode: Buried at least **30 inch** below grade and at least **24 inch** from base of tower or mounting.
2. Bond each tower base and metallic frame of dish to ring electrode, buried at least **18 inch** below grade.
3. Bond ring electrode and antenna bonding conductors to equipment room PBB or SBB, buried at least **30 inch** below grade.
4. Bond metal fences located within **6 ft** of towers and antennas to ring electrode, buried at least **18 inch** below grade.
5. Special Requirements for Roof-Mounted Towers:
 - a. Roof Ring: Meet requirements for ring electrode except conductors must comply with NFPA 780.
 - b. Bond tower base footings steel, SBB in equipment room, and antenna support guys to roof ring.
 - c. Connect roof ring to perimeter conductors of lightning protection system.
6. Special Requirements for Waveguides and Coaxial Cable:
 - a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
 - b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.6 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Acceptance Testing Preparation:

1. <Insert requirements>.

- B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.
- C. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells] [, and at individual ground rods]. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- D. Nonconforming Work:
1. Grounding system will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective components and retest.
- E. Collect, assemble, and submit test and inspection reports.
1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [10 Ω] <Insert ohms>.
 - b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [5 Ω] <Insert ohms>.
 - c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [3 Ω] <Insert ohms>.
 - d. Power Distribution Units or Panelboards Serving Electronic Equipment: [1 Ω] [3 Ω] <Insert ohms>.
 - e. Substations and Pad-Mounted Equipment: [5 Ω] <Insert ohms>.
 - f. Manhole Grounds: [10 Ω] <Insert ohms>.
 - g. <Insert application and maximum ground-resistance>.

3.7 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Support, anchorage, and attachment components.~~
- ~~2.1. Fabricated metal equipment support assemblies.~~

~~B. Related Requirements:~~

- ~~1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
- ~~2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.~~

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - j. **<Insert product type>.**

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: **[Signed and sealed by a qualified professional engineer.]** For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

~~2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS~~

- ~~A. Conduit and Cable Support Devices: [Steel] [Steel and malleable iron] [Stainless steel] [Glass fiber resin] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.~~
- ~~B. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.~~
- ~~C. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.~~
- ~~D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:~~
- ~~1. Concrete Inserts: Steel or malleable iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.~~
 - ~~2. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.~~
 - ~~3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.~~
 - ~~4. Toggle Bolts: [All] [Stainless] steel springhead type.~~
 - ~~5. Hanger Rods: Threaded steel.~~

2.32.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
1. NECA NEIS 101
 2. NECA NEIS 102.
 3. NECA NEIS 105.
 4. NECA NEIS 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."
- D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Provide [vibration] [and] [seismic] controls with hangers and supports in accordance with requirements specified in ["Section 260548 "Vibration and Seismic Controls for Electrical Systems."] ["Section 260548.16 "Seismic Controls for Electrical Systems."]
- F. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as [required by] [scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in] NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other] support system, sized so capacity can be increased by at least [25] <Insert number> percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with [two-bolt conduit clamps] [single-bolt conduit clamps] [single-bolt conduit clamps using spring friction action for retention in support channel].
- H. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, [EMT] [IMC] [and] [ERM] may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inch** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inch** thick.
 6. To Steel: **[Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69] [Spring-tension clamps]**.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate **[by means that comply with seismic-restraint strength and anchorage requirements]**.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than **4 inch** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use **[3000 psi] <Insert value>**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup:

1. 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.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils**.
 2. Comply with requirements in [Section 099113 "Exterior Painting"] [Section 099123 "Interior Painting"] [and] [Section 099600 "High-Performance Coatings"] <Insert painting Sections> for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ~~Type EMT-A and Type EMT-SS duct raceways and elbows.~~
2. ~~Type EMT-S duct raceways and elbows.~~
3. ~~Type ENT duct raceways and fittings.~~
4. ~~Type HDPE and Type EPEC duct raceways and fittings.~~
5. ~~Type ERMCA and Type ERMSS duct raceways, elbows, couplings, and nipples.~~
6. ~~Type ERMCS duct raceways, elbows, couplings, and nipples.~~
7. ~~Type FMC-S and Type FMC-A duct raceways.~~
8. ~~Type FMT duct raceways.~~
9. ~~Type IMC duct raceways.~~
10. ~~Type LFMC duct raceways.~~
11. ~~Type LFNC duct raceways.~~
12. ~~Type PVC duct raceways and fittings.~~
13. ~~Type RTRC-AG duct raceways and fittings.~~
14. ~~Type RTRC-BG duct raceways and fittings.~~
15. ~~Fittings for conduit, tubing, and cable.~~
16. ~~Electrically conductive corrosion-resistant compounds for threaded conduit.~~
17. ~~Solvent cements.~~

B. ~~Products Installed, but Not Furnished, under This Section:~~

1. ~~See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.~~

C.B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
4. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.2 DEFINITIONS

- A. Conduit: A structure containing one or more duct raceways.
- B. Duct Raceway: A single enclosed raceway for conductors or cable.

- C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Type EMT-A and Type EMT-SS duct raceways and elbows.
2. Type EMT-S duct raceways and elbows.
3. Type ENT duct raceways and fittings.
4. Type HDPE and Type EPEC duct raceways and fittings.
5. Type ERMCA and Type ERMSS duct raceways, elbows, couplings, and nipples.
6. Type ERMCS duct raceways, elbows, couplings, and nipples.
7. Type FMC-S and Type FMC-A duct raceways.
8. Type FMT duct raceways.
9. Type IMC duct raceways.
10. Type LFMC duct raceways.
11. Type LFNC duct raceways.
12. Type PVC duct raceways and fittings.
13. Type RTRC-AG duct raceways and fittings.
14. Type RTRC-BG duct raceways and fittings.
15. Fittings for conduit, tubing, and cable.
16. Electrically conductive corrosion-resistant compounds for threaded conduit.
17. Solvent cements.

B. Sustainable design submittals.

1. Solvent cements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Type EMT-A and Type EMT-SS duct raceways and elbows.
2. Type EMT-S duct raceways and elbows.
3. Type ENT duct raceways and fittings.
4. Type HDPE and Type EPEC duct raceways and fittings.
5. Type ERMCA and Type ERMSS duct raceways, elbows, couplings, and nipples.
6. Type ERMCS duct raceways, elbows, couplings, and nipples.
7. Type FMC-S and Type FMC-A duct raceways.
8. Type FMT duct raceways.
9. Type IMC duct raceways.
10. Type LFMC duct raceways.
11. Type LFNC duct raceways.
12. Type PVC duct raceways and fittings.
13. Type RTRC-AG duct raceways and fittings.
14. Type RTRC-BG duct raceways and fittings.
15. Fittings for conduit, tubing, and cable.

16. Electrically conductive corrosion-resistant compounds for threaded conduit.
17. Solvent cements.

PART 2 - PRODUCTS

2.1 TYPE EMT-A AND TYPE EMT-SS DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.2 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.3 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FKHU; including UL 1653.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.4 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN EAZX; including UL 651A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.5 TYPE ERMCA AND TYPE ERMCS DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYWV; including UL 6A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.6 TYPE ERMCS DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYIX; including UL 6.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.7 TYPE FMC-S AND TYPE FMC-A DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized

- by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.8 TYPE FMT DUCT RACEWAYS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria: UL CCN ILIW; including UL Subject 1652.

B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.9 TYPE IMC DUCT RACEWAYS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria: UL CCN DYBY; including UL 1242.

B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.10 TYPE LPMC DUCT RACEWAYS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:

- 1.—— Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2.—— Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.11——TYPE LFNC DUCT RACEWAYS

A.——Performance Criteria:

- 1.—— Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2.—— Listing Criteria: UL CCN DXOQ; including UL 1660.

B.——Source Quality Control:

- 1.—— Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2.—— Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.12——TYPE PVC DUCT RACEWAYS AND FITTINGS

A.——Performance Criteria:

- 1.—— Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2.—— Listing Criteria: UL CCN DZYR; including UL 651.

B.——Source Quality Control:

- 1.—— Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2.—— Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.13——TYPE RTRC-AG DUCT RACEWAYS AND FITTINGS

A.——Performance Criteria:

- 1.—— Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2.—— Listing Criteria:
 - a.—— Aboveground RTRC: UL CCN DZKT; including UL 2515.
 - b.—— Extra Heavy Wall RTRC: UL 2515A.

B.——Source Quality Control:

- 1.—— Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.14 TYPE RTRC-BG DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DZKT; including UL 2420.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.15 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.16 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.17 SOLVENT CEMENTS

A. Performance Criteria:

1. ~~Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~
2. ~~Listing Criteria: UL CCN DWTT; including UL 514B.~~

~~B. Source Quality Control:~~

1. ~~Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.~~
2. ~~Sustainable Design Submittals: Prepare and submit the following documentation:~~
 - a. ~~Product data indicating VOC content less than [510] [490] <Insert value> g/L or less for [PVC] [CPVC] conduit and fittings.~~
 - b. ~~Laboratory test reports for low-emitting materials, as recommended by solvent and adhesive manufacturer, that comply with 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."~~
3. ~~Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.~~

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE[**and EPEC**] underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE[**and Type EPEC**] underground conduits are not permitted to be used aboveground on Project.
- C. Outdoors:
 1. Exposed and Subject to Severe Physical Damage: [ERMC] [IMC].
 2. Exposed and Subject to Physical Damage: [ERMC] [IMC] [~~Corrosion-resistant~~ EMT].
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - b. ~~<Insert designations of applicable spaces or locations>.~~
 3. Exposed and Not Subject to Physical Damage: [ERMC] [IMC] [~~Corrosion-resistant~~ EMT] [PVC-80] [RTRC-AG].
 4. Concealed Aboveground: [ERMC] [IMC] [EMT] [PVC-80] [PVC-40] [RTRC-AG].
 5. Direct Buried: [PVC-80] [PVC-40] [HDPE-80] [HDPE-40] [RTRC-BG].
 6. Concrete Encased Not in Trench: [PVC-80] [PVC-40] [PVC-A] [RTRC-BG].
 7. Concrete Encased in Trench: [PVC-80] [PVC-40] [PVC-A] [PVC-EB] [HDPE-80] [HDPE-40] [EPEC-A] [EPEC-B] [RTRC-BG].
 8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [LFMC] [LFNC-A] [LFNC-B].
- D. Indoors:

1. Hazardous Classified Locations: [ERMC] [IMC].
 2. Exposed and Subject to Severe Physical Damage: [ERMC] [IMC]. Locations include the following:
 - a. Loading docks.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - e. <Insert designations of applicable spaces or locations>.
 3. Exposed and Subject to Physical Damage: [ERMC] [IMC] [EMT]. Locations include the following:
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - b. Stub-ups to above suspended ceilings.
 - c. <Insert designations of applicable spaces or locations>.
 4. Exposed and Not Subject to Physical Damage: [ERMC] [IMC] [EMT] [PVC-80] [RTRC-AG].
 5. Concealed in Ceilings and Interior Walls and Partitions: [ERMC] [IMC] [EMT] [PVC-80] [PVC-40] [RTRC-AG].
 6. Damp or Wet Locations: [ERMC] [IMC] [RTRC-AG] [Corrosion-resistant EMT].
 7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): [LFMC] [FMC] [LFNC-A] [LFNC-B].
 8. Circuits Operating Above 60 Hz: [EMT-A] [ERMC-A] [RTRC-AG]. Provide nonmetallic sleeve where aluminum duct raceways pass through concrete.
- E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
 2. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
 3. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
 4. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
 5. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
 6. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
 7. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
 8. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
 9. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
 10. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
 11. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
 12. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
 13. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
 14. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.

15. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
16. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
17. Expansion Fittings: NEMA FB 2.40.
18. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

- a. Complete duct raceway installation before starting conductor installation.
- b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft** above finished floor.
- c. Install no more than equivalent of three 90-degree bends in conduit run [**except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted**]. Support within **12 inch** of changes in direction.
- d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
- e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- f. Support conduit within **12 inch** of enclosures to which attached.
- g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
- h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2) Where an underground service duct raceway enters a building or structure.
 - 3) Conduit extending from interior to exterior of building.
 - 4) Conduit extending into pressurized duct raceway and equipment.
 - 5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 6) Where otherwise required by NFPA 70.
- i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
- j. Do not install conduits within **2 inch** of the bottom side of a metal deck roof.
- k. Keep duct raceways at least **6 inch** away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
- l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
- m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb** tensile strength. Leave at least **12 inch** of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
- n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 1) Termination fittings with shoulders do not require two locknuts.

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- a. Provide EMT, IMC, or ERM for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
 10. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. [**Install insulated throat metal grounding bushings on service conduits**].
 11. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 - a. ERM-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - b. EMT: Provide [**setscrew**] [**compression**], [**steel**] [**cast-metal**] fittings. Comply with NEMA FB 2.10.
 - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
 12. Expansion-Joint Fittings:
 - a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed **30 deg F** and that have straight-run length that exceeds **25 ft**. Install in runs of aboveground ERM[**and EMT**] conduit that are located where environmental temperature change may exceed **100 deg F** and that have straight-run length that exceeds **100 ft**.
 - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - 1) Outdoor Locations Not Exposed to Direct Sunlight: [**125 deg F**] <Insert temperature> temperature change.
 - 2) Outdoor Locations Exposed to Direct Sunlight: [**155 deg F**] <Insert temperature> temperature change.
 - 3) Indoor Spaces Connected with Outdoors without Physical Separation: [**125 deg F**] <Insert temperature> temperature change.
 - 4) Attics: [**135 deg F**] <Insert temperature> temperature change.
 - 5) <Insert location and corresponding temperature change>.
 - c. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.00078 inch per foot of length of straight run per deg F** of temperature change for metal conduits.
 - d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
 - e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
 13. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty[**or firestopping**].
 14. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
 - a. Provide warning signs.
 15. <Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions>.
- D. Interfaces with Other Work:

1. Coordinate installation of new products for <Insert system or product family/category> with existing conditions.
 - a. <Insert requirements for transition between new and existing>.
2. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
3. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.
4. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.
 - a. <Insert requirements for transition between this Section and related Work>.

3.3 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Metallic outlet boxes, device boxes, rings, and covers.~~
- ~~2. Nonmetallic outlet boxes, device boxes, rings, and covers.~~
- ~~3. Junction boxes and pull boxes.~~
- ~~4.1. Cover plates for device boxes.~~
- ~~5. Hoods for outlet boxes.~~

~~B. Products Installed, but Not Furnished, under This Section:~~

- ~~1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.~~

~~C.B.~~ Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Shop Drawings:

1. Shop drawings for floor boxes.

C. Samples:

1. Floor box samples for initial selection.
2. Raised floor box samples for initial selection.
3. Recessed access-floor box samples for initial selection.
4. Concrete box samples for initial selection.

- D. Sustainable design submittals.
 - 1. Nonmetallic outlet boxes, device boxes, rings, and covers.
 - 2. Junction boxes and pull boxes.
 - 3. Cover plates for device boxes.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions:
 - 1. Metallic outlet boxes, device boxes, rings, and covers.
 - 2. Nonmetallic outlet boxes, device boxes, rings, and covers.
 - 3. Junction boxes and pull boxes.
 - 4. Cover plates for device boxes.
 - 5. Hoods for outlet boxes.

PART 2 - PRODUCTS

2.1 ~~METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS~~

A. ~~Performance Criteria:~~

- 1. ~~Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~
- 2. ~~Listing Criteria: UL CCN QCIT; including UL 514A.~~

B. ~~Source Quality Control:~~

- 1. ~~Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.~~
- 2. ~~Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.~~
- 3. ~~Samples:~~
 - a. ~~Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.~~
 - b. ~~Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.~~
 - c. ~~Recessed Access Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.~~
 - d. ~~Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.~~

2.2 ~~NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS~~

A. ~~Performance Criteria:~~

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN-QCMZ; including UL 514C.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesive solvents:
 - a. Product data indicating VOC content less than ~~[510]~~ ~~[490]~~ ~~<Insert value>~~ g/L or less for ~~[PVC]~~ ~~[CPVC]~~ conduit and fittings.
 - b. Laboratory test reports for low-emitting materials, as recommended by solvent and adhesive manufacturer, that comply with 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."
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
4. Samples:
 - a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - c. Recessed Access Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

2.3 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN-BGUZ; including UL 50 and UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesive solvents:
 - a. Product data indicating VOC content less than ~~[510]~~ ~~[490]~~ ~~<Insert value>~~ g/L or less for ~~[PVC]~~ ~~[CPVC]~~ conduit and fittings.
 - b. Laboratory test reports for low-emitting materials, as recommended by solvent and adhesive manufacturer, that comply with 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."
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.4 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN-QCIT or UL CCN-QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation for adhesive solvents:
 - a. Product data indicating VOC content less than [510] [490] <Insert value> g/L or less for [PVC] [CPVC] conduit and fittings.
 - b. Laboratory test reports for low-emitting materials, as recommended by solvent and adhesive manufacturer, that comply with 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."
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.5 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:
 - a. UL CCN-QCIT or UL CCN-QCMZ; including UL 514D.
 - b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
3. Mounts to box using fasteners different from wiring device.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness **[at location]** where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

3.2 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 1. Outdoors:
 - a. **[Type 3R] [Type 4] [Type 3]** unless otherwise indicated.
 - b. Locations Exposed to Hosedown: **[Type 4] [Type 6] [Type 6P]**.
 - c. Locations Subject to Potential Flooding: Type 6P.
 - d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
 - e. Locations in-Ground or Exposed to Corrosive Agents: **[Type 4X] [Type 6P] [Type 3RX]**.
 - f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.
 2. Indoors:
 - a. Type 1 unless otherwise indicated.
 - b. Damp or Dusty Locations: **[Type 12] [Type 2] [Type 4] [Type 5]**.
 - c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
 - d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: **[Type 12] [Type 12K]**.
 - e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: **[Type 4] [Type 6]**.
 - f. Locations Exposed to Hosedown: **[Type 4] [Type 6] [Type 6P]**.
 - g. Locations Exposed to Brief Submersion: **[Type 6] [Type 6P]**.
 - h. Locations Exposed to Prolonged Submersion: Type 6P.
 - i. Locations Exposed to Corrosive Agents: **[Type 4X] [Type 6P]**.
 - j. Locations Exposed to Spraying Oil or Coolants: Type 13.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
 1. **[Provide cast-metal boxes] [Boxes with knockouts or unprotected openings are prohibited]**.
 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
 2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **[center]** **[top]** **[bottom]** of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for wallplates and covers.
14. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each box with engraved metal or laminated-plastic nameplate.
15. **<Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' published instructions>.**

D. Interfaces with Other Work:

1. Coordinate installation of new products for **<Insert system or product family/category>** with existing conditions.
 - a. **<Insert requirements for transition between new and existing>.**
2. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
3. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard on input feeder.
4. Coordinate with **<Insert Section number and title>** for **<Insert description of interfacing related Work>.**
 - a. **<Insert requirements for transition between this Section and related Work>.**

3.4 CLEANING

- A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.5 PROTECTION

- A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ~~Type EPEC raceways and fittings.~~
2. ~~Type ERMCS raceways, elbows, couplings, and nipples.~~
3. ~~Type ERMCS raceways, elbows, couplings, and nipples.~~
4. ~~Type IMC raceways.~~
5. ~~Type PVC raceways and fittings.~~
6. ~~Type RTRC-BG raceways and fittings.~~
7. ~~Fittings for conduit, tubing, and cable.~~
8. ~~Electrically conductive corrosion-resistant compounds for threaded conduit.~~
9. ~~Solvent cements.~~
10. ~~Duct accessories.~~
11. ~~Handholes and boxes for exterior underground wiring.~~
12. ~~Manholes for exterior underground wiring.~~
13. ~~Utility structure accessories.~~
14. ~~Duct sealing.~~

B. ~~Related Requirements:~~

1. ~~Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
2. ~~Section 260011 "Facility Performance Requirements for Electrical" specifies seismic load, wind load, acoustical, and other field conditions applicable to Work specified in this Section.~~
3. ~~[Section 013100 "Project Management and Coordination"] <Insert Section number and title> specifies preinstallation conference procedures.~~
4. ~~Section 260519 "Low Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).~~
5. ~~Section 260553 "Identification for Electrical Systems" specifies underground line warning tape and concrete cable routing markers (warning planks).~~

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

- A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

- A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.
- B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.
- C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.
- D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.
- B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) **[as videoconference]** **[or]** **[at Project site]** **<Insert location>** before **<Insert construction activity>**.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections. Notify Architect**[, Construction Manager]** **[, and Owner's Commissioning Authority]** of scheduled meeting dates.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For concrete and steel used in precast concrete **[manholes]** **[and]** **[handholes]**, also include product certificates as required by ASTM C858.
- B. Sustainable Design Product Data:
 - 1. Product Data: For solvents and adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings:
 - 1. Electric Utility Duct Banks and Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Indicate locations of private property boundaries and utility easements.
 - c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Precast or Factory-Fabricated Concrete Structures:

- a. Include plans, elevations, sections, and details, including attachments to other Work.
- b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
- c. Include reinforcement details.
- d. Include frame and cover design and manhole chimneys.
- e. Include **[ladder]** **[step]** details.
- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
- h. Include joint details.

3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

D. Field quality-control reports.

1.8 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

B. Field Reports:

1. Factory Test Reports: For handholes and boxes.
2. Manufacturer's field reports for field quality-control support.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts necessary for repairing or adding more cables to manholes or handholes that are packaged with protective covering for storage and identified with labels describing contents.

1. Cable-Support Stanchions, Arms, and Associated Fasteners: **[Five]** **<Insert number>** percent of quantity of each item installed.
2. Insulators: **[Five]** **<Insert number>** percent of quantity of each item installed.
3. **<Insert accessories and specialties>**.

1.10 REGULATORY AGENCY APPROVALS

A. Shop Drawing submittals for electric utility duct banks and structures must be signed and sealed by qualified electrical professional engineer responsible for their preparation. **[Obtain approval by electric utility prior to submitting for action by Architect.]** **[Submit for action by Architect prior to submitting for approval by electric utility.]**

- B. Submit Shop Drawings for electric utility duct banks and structures for action by Architect prior to submitting for approval by electric utility.

PART 2 - PRODUCTS

2.1 ~~TYPE EPEC RACEWAYS AND FITTINGS~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.~~
- ~~2. General Characteristics: UL 651A and UL CCN EAZX.~~

2.2 ~~TYPE ERMCS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.~~
- ~~2. General Characteristics: UL 6A and UL CCN DYWV.~~

2.3 ~~TYPE ERMCS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.~~
- ~~2. General Characteristics: UL 6 and UL CCN DYIX.~~

2.4 ~~TYPE IMC RACEWAYS~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.~~
- ~~2. General Characteristics: UL 1242 and UL CCN DYBY.~~

2.5 ~~TYPE PVC RACEWAYS AND FITTINGS~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.~~
- ~~2. General Characteristics: UL 651 and UL CCN DZYR.~~

2.6 ~~TYPE RTRC-BG RACEWAYS AND FITTINGS~~

A. ~~Performance Criteria:~~

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2.8 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:
 - a. VOC Content: [510] [490] <Insert value> g/L or less for [PVC] [CPVC] conduit and fittings.
 - b. Low-Emitting Material Requirements: As recommended by solvent and adhesive manufacturer and that complies 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."

2.9 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.

2.10 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.

B. Cast-in-Place Concrete Manholes:

1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

2. ~~Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."~~

2.112.1 SOURCE QUALITY CONTROL

A. Factory Tests for Handholes and Boxes:

1. Testing Administrator: **[Owner will engage] [Engage]** qualified structural testing agency to evaluate handholes and boxes.
 - a. Tests of materials must be performed by independent testing agency.
 - b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.
2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of **[manufacturer's] [qualified testing laboratory's]** certification of system compliance.
 - a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
 - b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
3. Nonconforming Work:
 - a. Equipment that does not pass tests and inspections will be considered defective.
4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 311000 "Site Clearing."

3.2 SELECTION OF UNDERGROUND DUCTS

- A. Duct for Electrical Cables More Than 600 V: [PVC-80] [PVC-40] [EPEC-40] [EPEC-80], concrete encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: [PVC-80] [PVC-40] [EPEC-40] [EPEC-80], [concrete encased] [direct buried] unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: [PVC-80] [PVC-40] [EPEC-40] [EPEC-80], direct buried unless otherwise indicated.
- D. Bored Underground Duct: [EPEC-40] [EPEC-80] unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths Walks and Driveways: [PVC-80] [PVC-40] [direct buried] [encased in reinforced concrete].
- F. Underground Ducts Crossing Roadways and Railroads: [PVC-80] [PVC-40], encased in reinforced concrete.
- G. Stub-ups: Concrete encased, [PVC-80] [PVC-40] [ERMC-S] [ERMC-S-PVC] [IMC].

3.3 SELECTION OF UNDERGROUND ENCLOSURES

- A. Handholes and Boxes:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, [H-10] [H-20] structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: [Precast concrete, AASHTO HB 17, H-10] [Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15] [Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15] [Fiberglass-reinforced polyester resin, SCTE 77, Tier 15] [High-density plastic, SCTE 77, Tier 15] structural load rating.
 - 3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: [Precast concrete, AASHTO HB 17, H-10] [Polymer concrete units, SCTE 77, Tier 8] [Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8] [High-density plastic, SCTE 77, Tier 8] structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: [Fiberglass-reinforced polyester resin] [High-density plastic], structurally tested in accordance with SCTE 77 with 3000 lbf vertical loading.
 - 5. Cover design load must not exceed load rating of handhole or box.
- B. Manholes: [Precast] [or] [cast-in-place] concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Restore area [immediately after backfilling is completed] [or] [after construction vehicle traffic in immediate area is complete].

- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

- 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
- 2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

- 1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- 2. Steel raceway, bends, and fittings in [single duct run or duct bank] [on Project] must be of same type.
- 3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
- 4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
- 5. Install expansion fitting near center of straight line duct with calculated expansion of more than **3/4 inch**.
- 6. Curves and Bends:
 - a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of [**48 inch**] [**12.5 ft**] [**25 ft**], both horizontally and vertically, at other locations unless otherwise indicated.
 - b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of [**48 inch**] [**12.5 ft**] [**25 ft**]. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
 - c. Duct must have maximum of 180 degrees of bends between pull points.
- 7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.
 - a. Install insulated grounding bushings on steel raceway terminations that are less than **12 inch** below grade or floor level and do not terminate in hubs.
- 8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above **104 deg F**. Where environmental temperatures are calculated to rise above **104 deg F**, and anywhere duct crosses above underground steam line, install

- insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of **104 deg F**.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inch** o.c. for **5 inch** duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to end-bell spacing **10 ft** from end bell, without reducing duct slope and without forming trap in line.
 - b. Grout end bells into structure walls from both sides to provide watertight entrances.
 10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately **6 inch** o.c. for **4 inch** duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to terminator spacing **10 ft** from terminator, without reducing duct line slope and without forming trap in line.
 11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least **10 ft** outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
 12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete for minimum of **12 inch** on each side of coupling.
 13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15 psig** hydrostatic pressure.
 14. Pulling Cord: Install **200 lbf** test nylon cord in empty ducts.
 15. Concrete-Encased Ducts and Duct Bank:
 - a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes **6 inch** or less in nominal diameter.
 - b. Width: Excavate trench **[3 inch] [12 inch]** wider than duct on each side.
 - c. Depth: Install so top of duct envelope is at least **24 inch** below finished grade in areas not subject to deliberate traffic, and at least **30 inch** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
 - d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than **[four] [five]** spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - f. Minimum Space between Ducts: **3 inch** between edge of duct and exterior envelope wall, **2 inch** between ducts for like services, and **4 inch** between power and communications ducts.
 - g. Elbows:
 - 1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.

- 2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of equipment base.
 - 1) Stub-ups must [**terminate in coupling installed flush with**] [**be minimum 4 inch above**] finished floor and minimum **3 inch** from conduit side to edge of slab.
 - i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups must [**terminate in coupling installed flush with**] [**be minimum 4 inch above**] finished floor and no less than **3 inch** from conduit side to edge of slab.
 - j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - l. Concrete Cover: Install minimum of **3 inch** of concrete cover between edge of duct to exterior envelope wall, **2 inch** between duct of like services, and **4 inch** between power and communications ducts.
 - m. Place minimum **6 inch** of engineered fill above concrete encasement of duct.
 - n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - 1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
 - 2) If more than one pour is necessary, terminate each pour in vertical plane and install **3/4 inch** reinforcing-rod dowels extending minimum of **18 inch** into concrete on both sides of joint near corners of envelope.
 - o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
16. Direct-Buried Duct and Duct Bank:
- a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inch** in nominal diameter.
 - b. Width: Excavate trench [**3 inch**] [**12 inch**] wider than duct on each side.
 - c. Depth: Install top of duct at least **36 inch** below finished grade unless otherwise indicated.
 - d. Set elevation of top of duct bank below frost line.
 - e. Place minimum **3 inch** of sand as bed for duct. Place sand to minimum of **6 inch** above top level of duct.
 - f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [**four**] [**five**] spacers per **20 ft** of duct. Place spacers within **24 inch** of duct ends. Stagger spacers approximately **6 inch** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops

- around ducts or duct groups.
- h. Install duct with minimum of **3 inch** between ducts for like services and **6 inch** between power and communications duct.
 - i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - 1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum **3 inch** of concrete.
 - 2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of **60 inch** from edge of base. Install insulated grounding bushings on terminations at equipment.
 - a) Stub-ups must **[terminate in coupling installed flush with] [be minimum 4 inch above]** finished base and minimum **3 inch** from conduit side to edge of base.
 - 3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of **60 inch** from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 4) Stub-ups through interior floors must **[terminate in coupling installed flush with] [be minimum 4 inch above]** finished floor and no less than **3 inch** from conduit side to edge of equipment pad or floor slab.
 - k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inch** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
- 17. Warning Planks: Bury warning planks approximately **12 inch** above direct-buried duct, placing them **36 inch** o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional planks **12 inch** apart, horizontally across width of ducts.
 - 18. Underground-Line Warning Tape: Bury **[nonconducting] [conducting]** underground line specified in Section 260553 "Identification for Electrical Systems" no less than **12 inch** above concrete-encased duct and duct banks **[and approximately 12 inch below grade]**. Align tape parallel to and within **3 inch** of centerline of duct bank. Provide additional warning tape for each **12 inch** increment of duct-bank width over nominal **18 inch**. Space additional tapes **12 inch** apart, horizontally across width of ducts.
 - 19. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Interfaces with Other Work:
- 1. Coordinate installation of new products for **<Insert system or product group>** with existing conditions.
 - a. **<Insert requirements for transition between new and existing>**.
 - 2. Coordinate with **<Insert Section number and title>** for **<Insert description of interfacing related Work>**.
 - a. **<Insert requirements for transition between this Section and related Work>**.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:
 - a. Finish interior surfaces with smooth-troweled finish.
 - b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inch** thick, arranged as indicated.
 - c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
2. Precast Concrete Handholes and Manholes:
 - a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
 - b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from **1 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
 - c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3. Elevations:
 - a. Manhole Roof: Install with rooftop at least **15 inch** below finished grade.
 - b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch** above finished grade.
 - c. Install handholes with bottom below frost line, **<Insert depth of frost line below grade at Project site>** below grade.
 - d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
 - e. Where indicated, cast handhole cover frame integrally with handhole structure.
4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - b. Install chimney, constructed of **[precast concrete]** **[cast-iron]** collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.
6. Waterproofing: Apply waterproofing to exterior surfaces of manholes **[and handholes]** after concrete has cured at least three days. Waterproofing materials and installation are specified in **[Section 071353 "Elastomeric Sheet Waterproofing"]** **[Section 071354 "Thermoplastic Sheet Waterproofing"]** **<Insert waterproofing Section>**. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

7. Dampproofing: Apply dampproofing to exterior surfaces of manholes[**and handholes**] after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [**and**] cable arms, [**and insulators**], as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inch** for manholes and **2 inch** for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for **<Insert system or product group>** with existing conditions.
 - a. **<Insert requirements for transition between new and existing>**.
2. Coordinate with **<Insert Section number and title>** for **<Insert description of interfacing related Work>**.
 - a. **<Insert requirements for transition between this Section and related Work>**.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. **<Insert reference standard>** for **<Insert reason>**.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from **1/2 inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
4. Install handholes and boxes with bottom below frost line, **<Insert depth of frost line below grade at Project site>** below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in [**asphalt paving**] [**and**] **<Insert material>** and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of

box cover frame. Bottom of ring must rest on [compacted earth] <Insert material>.

- a. Concrete: **3000 psi**, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
- b. Dimensions: [**10 inch wide by 12 inch deep**] <Insert dimensions>.

8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:

1. Coordinate installation of new products for <Insert system or product group> with existing conditions.
 - a. <Insert requirements for transition between new and existing>.
2. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.
 - a. <Insert requirements for transition between this Section and related Work>.

3.8 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. <Insert requirements>.

B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.

C. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch** long mandrel equal to duct size minus **1/4 inch**. If obstructions are indicated, remove obstructions and retest.
3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

D. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Elastomeric isolation pads.~~
- ~~2. Restraints - rigid type.~~
- ~~3. Restraints - cable type.~~
- ~~4. Restraint accessories.~~
- ~~5. Post-installed concrete anchors.~~
- ~~6. Concrete inserts.~~

B. ~~Related Requirements:~~

- ~~1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
- ~~2. Section 260011 "Facility Performance Requirements for Electrical" for seismic load, wind load, acoustical, and other field conditions applicable to Work specified in this Section.~~
- ~~3. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.~~

1.2 DEFINITIONS

- A. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 ACTION SUBMITTALS

A. Product Data:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-installed concrete anchors.
6. Concrete inserts.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic and wind-load bracing for components with other systems and equipment in the vicinity,

including other supports and seismic restraints.

- C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.
 - 1. For each seismic-restraint device, including **[restraint - rigid and cable type,]** **[restraint accessory,]** **[and]** **[concrete anchor and insert]** that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.
 - c. Seismic Design Calculations: Submit input data and loading calculations prepared in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."
- D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
 - 1. For each wind-load protection device, including **[restraint - rigid and cable type,]** **[restraint accessory,]** **[and]** **[concrete anchor and insert]** that is required by this Section or is indicated on Drawings, submit the following:
 - a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by qualified testing laboratory for reinforcement use.
 - c. Wind-Load Design Calculations: Submit static and dynamic loading calculations prepared in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."
 - 2. Seismic- and Wind-Load-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
 - a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. 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 details with wind-load details required for equipment mounted outdoors.
 - 3. Product Listing, Preapproval, and Evaluation Documentation: By **[an evaluation service member of ICC-ES]** **[UL]** **[FM Approvals]** **[OSHDP]** **[an agency acceptable to authorities having jurisdiction]**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage qualified structural professional engineer to design seismic and wind-load control system in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."
- B. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: **[ICC-ES product listing] [UL product listing] [FM Approvals] [an evaluation service member of ICC-ES] [an agency acceptable to authorities having jurisdiction]**.
- C. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- D. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:
 - 1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

~~2.2 POST-INSTALLED CONCRETE ANCHORS~~

- ~~A. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.
 - ~~1. Prequalify post-installed anchors in concrete in accordance with ACI 308.4 or other approved qualification testing procedures.~~
 - ~~2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.~~~~
- ~~B. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.
 - ~~1. Undercut expansion anchors are permitted.~~~~

~~2.32.2~~ SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, **[diagrams,] [schedules,]** and performance data illustrating size, physical appearance, and other characteristics of product.
 - 1. Include rated load capacity for each seismic- and wind-load-restraint device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-load-restraint component used.
 - 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load

- rating in tension and compression as evaluated by [ICC-ES product listing] [UL product listing] [FM Approvals] [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].
4. Annotate to indicate application of each product submitted and compliance with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for 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 Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT AND WIND-LOAD CONTROL DEVICES

- A. Provide seismic restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
 - 1. Install equipment and devices to withstand the effects of earthquake motions and high wind events.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- C. Installation of seismic and wind-load restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch**.
 - 2. Install seismic-restraint and wind-load-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] that provides required submittals for component.

- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch**.
 - 2. Install seismic-restraint and wind-load-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
 - 3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch**.
 - 4. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. 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.
- H. 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.
- I. Post-Installed Concrete 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 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. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: 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 runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.
- B. 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 no fewer than [four] <Insert number> of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
- C. Nonconforming Work:
1. Seismic controls will be considered defective if they do not pass tests and inspections.
 2. Remove and replace malfunctioning units and retest as specified above.
- D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Labels.~~
- ~~2. Extruded insulating tubing.~~
- ~~3. Bands.~~
- ~~4. Tapes and stencils.~~
- ~~5. Tags.~~
- ~~6. Signs.~~
- ~~7. Cable ties.~~

B. ~~Related Requirements:~~

- ~~1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
- ~~2. Section 260011 "Facility Performance Requirements for Electrical" for seismic load, wind load, acoustical, and other field conditions applicable to Work specified in this Section.~~

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

~~2.1 LABELS~~

A. ~~Performance Criteria:~~

- ~~1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~
- ~~2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.~~

2.2 — EXTRUDED INSULATING TUBING

A. — Performance Criteria:

1. — Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. — Listing Criteria: UL CCN YDPU2 for components; including UL 224.

2.3 — TAPES AND STENCILS

A. — Concrete Cable Route Markers <Insert drawing designation>:

1. — Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. — Product Characteristics:

- a. — Material: Precast reinforced concrete.
- b. — Marker Type:

1) — Above-Ground Monument Post:

- a) — Nominal Dimensions (Height, Width, Depth): **30 inch, 6 inch, 3 inch.**

2) — Above-Ground Monument Block:

- a) — Nominal Dimensions (Height, Width, Depth): [12 inch, 12 inch, 6 inch] [24 inch, 24 inch, 4 inch].

3) — In-Ground Protective Cover (Plank or Slab):

- a) — Nominal Dimensions (Length, Width, Depth): [36 inch, 6 inch, 2 inch] [36 inch, 9 inch, 2 inch] [12 inch, 12 inch, 2 inch] [24 inch, 12 inch, 2 inch] [36 inch, 12 inch, 2 inch].

- c. — Legend: ["DANGER - ELECTRICITY"] ["ELECTRIC CABLES"] ["ELECTRIC SPLICE"].
- d. — Lettering: Approximately 1/8 inch deep, not less than [1 inch] [1.5 inch] high, symmetrically spaced; marked on both sides to allow for reversal.

3. — Required Product Options:

- a. — Color: [Red] <Insert color> dye added to concrete during batching.
- b. — Attach metal medallion or sign stamped with [feeder number] <Insert required information>.

B. — Stenciled Legend: In nonfading, waterproof, [black] <Insert color> ink or paint. Minimum letter height must be [1 inch] <Insert dimension>.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

- A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:
1. Fire-protection[**and fire-alarm**] equipment[, **including raceways**,] must be finished, painted, or suitably marked safety red.
 2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than **[7.7 ft]** **<Insert height>** above finished floor.
- B. Pipe and Conduit Labeling: Comply with ASME A13.1 [**and IEEE C2**].
- C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded [service] [feeder] [and] [branch-circuit] conductors.
1. Color must be factory applied[**or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction**].
 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 3. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 4. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 5. Color for Neutral (Grounded Conductor): [White] [or] [gray].
 6. Color for Equipment Ground: [Bare copper] [Green] [Green with yellow stripe].
 7. Color for Isolated Ground: Green with two or more yellow stripes.
- D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.
- E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and

system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
 4. <Insert name>.
- G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- H. Locations of Underground Lines: Underground-line warning tape for power and lighting.
- I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use **[write-on tags]** **[nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation]**.
- J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with **3 inch** high, black letters on **20 inch** centers.
1. Locate identification at changes in direction, at penetrations of walls and floors, and at **[10 ft]** **[30 ft]** maximum intervals.
 2. Identify system voltage **[and system or service type]** with black letters on orange field.
 3. Apply floor marking tape to the following finished surfaces:
 - a. Floor surface directly above conduits running beneath and within **12 inch** of floor that is in contact with earth or is framed above unexcavated space.
 - b. Wall surfaces directly external to raceways concealed within wall.
 - c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.
- K. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: **[Vinyl wraparound labels]** **[Snap-around labels]** **[Self-adhesive labels]** **[Snap-around color-coding bands for raceway and cables]**.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft** maximum intervals in straight runs, and at **25 ft** maximum intervals in congested areas.
 2. Identify system voltage **[and system or service type]** with black letters on orange field.
- L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use **[vinyl wraparound labels]** **[self-adhesive wraparound labels]** **[snap-around labels]** **[snap-around color-coding bands]** **[self-adhesive vinyl tape]** to identify phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft** maximum intervals in straight runs, and at **25 ft** maximum intervals in congested areas.
 2. Identify system voltage **[and system or service type]** with **[black letters on orange field]** **<Insert color scheme>**.
- M. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than **[30]** **<Insert number>** A and **[120]** **<Insert number>** V to Ground: Identify with self-adhesive **[raceway labels]** **[vinyl tape applied in bands]**.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50 ft** maximum intervals in straight runs, and at **25 ft** maximum intervals in congested areas.
 2. Identify system voltage **[and system or service type]** with **[black letters on orange field]** **<Insert color scheme>**.

- N. Conductors to Be Extended in Future: Attach **[write-on tags]** **[marker tape]** to conductors **[and list source]**.
- O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:
1. Panelboard designation.
 2. Colon or dash.
 3. Branch circuit number.
- P. Workspace Indication: Apply **[floor marking tape]** **[or]** **[tape and stencil]** to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- Q. Equipment Identification Labels:
1. Black letters on white field.
 2. Indoor Equipment: **[Self-adhesive label]** **[Baked-enamel signs]** **[Metal-backed butyrate signs]** **[Laminated acrylic or melamine plastic sign]**.
 3. Outdoor Equipment: **[Laminated acrylic or melamine sign]** **[Stenciled legend 4 inch high]**.
 4. Equipment to Be Labeled:
 - a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels **[containing equipment designation]**.
 - b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of **[self-adhesive, engraved,]** **[engraved,]** laminated acrylic or melamine label.
 - c. Enclosures and electrical cabinets.
 - d. Access doors and panels for concealed electrical items.
 - e. Switchgear.
 - f. Switchboards.
 - g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - h. Substations.
 - i. Emergency system boxes and enclosures.
 - j. Motor-control centers.
 - k. Enclosed switches.
 - l. Enclosed circuit breakers.
 - m. Enclosed controllers.
 - n. Variable-speed controllers.
 - o. Push-button stations.
 - p. Power-transfer equipment.
 - q. Contactors.
 - r. Remote-controlled switches, dimmer modules, and control devices.
 - s. Uninterruptible power supplies.
 - t. Battery-inverter units.
 - u. Battery racks.
 - v. Power-generating units.
 - w. Monitoring and control equipment.
 - x. **<Insert equipment>**.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

~~3.3 SELECTION OF SIGNS AND HAZARD MARKINGS~~

~~A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.~~

~~B. Signs, labels, and tags required for personnel safety must comply with the following standards:~~

- ~~1. Safety Colors: NEMA Z535.1.~~
- ~~2. Facility Safety Signs: NEMA Z535.2.~~
- ~~3. Safety Symbols: NEMA Z535.3.~~
- ~~4. Product Safety Signs and Labels: NEMA Z535.4.~~
- ~~5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.~~

~~C. Electrical Hazard Warnings:~~

- ~~1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with [NFPA 70E] [and] [Section 260573.19 "Arc-Flash Hazard Analysis"] requirements for arc-flash hazard warning labels.~~
- ~~2. Raceways and Cables Carrying Circuits at More Than 1000 V:~~
 - ~~a. Black letters on orange field.~~
 - ~~b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."~~
- ~~3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."~~
- ~~4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."~~
- ~~5. <Insert names and wording of warning signs or labels (for example, multiple services and voltages, and others)>.~~

~~D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: [Self-adhesive labels] [Baked-enamel warning signs] [Metal-backed, butyrate warning signs].~~

- ~~1. Apply to exterior of door, cover, or other access.~~
- ~~2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:~~
 - ~~a. Power-transfer switches.~~
 - ~~b. Controls with external control power connections.~~
 - ~~c. <Insert items>.~~

~~E. Operating Instruction Signs: [Self-adhesive labels] [Baked-enamel warning signs] [Metal-backed, butyrate warning signs] [Laminated acrylic or melamine plastic signs].~~

~~F. Emergency Operating Instruction Signs: [Self-adhesive labels] [Baked-enamel warning signs] [Metal-backed, butyrate warning signs] [Laminated acrylic or melamine plastic signs] with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for [power transfer] [load shedding] <Insert emergency operations>.~~

3.43.3 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

- A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.53.4 INSTALLATION

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 260011 "Facility Performance Requirements for Electrical."
- C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.
- E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- F. Install identifying devices before installing acoustical ceilings and similar concealment.
- G. Verify identity of item before installing identification products.
- H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- I. Apply identification devices to surfaces that require finish after completing finish work.
- J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

- Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of **6 inch** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- U. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape not less than **12 inch** directly above cables or raceways buried **18 inch** or more below grade. Use multiple tapes where width of multiple lines installed in common trench [or concrete envelope] exceeds **16 inch** overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- V. Concrete Cable Route Markers: [As indicated on Drawings] <Insert Project-specific requirements>.
- W. Metal Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using [general-purpose] [UV-stabilized] [plenum-rated] cable ties.
- X. Nonmetallic Preprinted Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using [general-purpose] [UV-stabilized] [plenum-rated] cable ties.
- Y. Write-on Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using [general-purpose] [UV-stabilized] [plenum-rated] cable ties.
- Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 260553

SECTION 260936 - MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall-box multiscene dimming controls.
 - 2. Multipreset modular dimming controls.
 - 3. Conductors and cables.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- B. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- C. SCR: Silicon-controlled rectifier.
- D. Zone: A luminaire or group of luminaires controlled simultaneously as a single entity. Also known as a "channel."

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Wall-box multiscene dimming controls.
 - 2. Multipreset modular dimming controls.
 - 3. Conductors and cables.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 1. Include elevation views of front panels of control and indicating devices and control stations.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
 - 4. Point List and Data Bus Load: Summary list of control devices, sensors, ballasts, and other loads. Include percentage of rated

- connected load and device addresses.
5. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
 6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.
 7. Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in **[Section 230923 "Direct Digital Control (DDC) System for HVAC"]** <Insert Section number and title>.
 - a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
 - b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.
- C. Samples for Initial Selection: For master- and remote-control stations, and cover plates with factory-applied color finishes and technical features.
- D. Samples for Verification: For master- and remote-control stations, and cover plates with factory-applied color finishes and technical features.
- E. Field quality-control reports.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Sample Warranty: For special warranty.
- 1.5 WARRANTY
- A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of modular dimming controls perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: **[Two]** **[Three]** **[Four]** <Insert number> year(s) from date of Substantial Completion, for labor, materials, and equipment.
 2. Follow-on Extended Warranty Period: **[Eight]** <Insert number> year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Compatibility:
1. Dimming control components must be compatible with **[luminaires]** **[luminaires and ballasts]** **[luminaires, ballasts, and transformers]**.
 2. Dimming control devices must be compatible with lighting control system components specified in Section 260943.16 "Addressable Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls," and in Section 260923

"Lighting Control Devices."

- B. Dimmers and Dimmer Modules: Comply with UL 508.
 - 1. Audible Noise and RFI Suppression: Solid-state dimmers must operate smoothly over their operating ranges without audible lamp or dimmer noise or RFI. Modules must include integral or external filters to suppress audible noise and RFI.
 - 2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- C. Capacities: Unit must be rated for **[2400 W at 240 V(ac) and 2000 W at 120 V(ac)]** <Insert value> for up to **[100]** <Insert number> devices or zones.
- D. Surge Protection: Withstand supply power surges without impairment to performance.
 - 1. Panels: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
 - 2. Other System Devices: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
- E. Off Control Position: User-selected off position of any control point must disconnect the load from line supply.
- F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 WALL-BOX MULTISCENE DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of a wall-box-mounted master controller[**and indicated number of wall-box zone stations**]. Controls and dimmers must be integrated for mounting in multigang wall box under a single wall plate. Each zone must be adjustable to indicated number of scenes, which must reside in the memory of zone controller.
- B. Dimmers:
 - 1. Each zone must be configurable to control the following loads:
 - a. Fluorescent lamps with **[electronic]** **[magnetic]** ballasts.
 - b. LED lamps.
 - c. Incandescent lamps.
 - d. Control-voltage lamps, derived with **[magnetic]** **[electronic]** transformers.
 - e. Non-dim, on-off switching only.
 - f. **<Insert special lighting equipment>**.
 - 2. Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.
- C. Memory:
 - 1. Retain preset scenes and fade rates through momentary (up to 3 s) power interruptions.
 - 2. Retain preset scenes through power failures for at least **[seven]** **<Insert number>** days.
- D. Device Cover Plates: Style, material, and color **[must comply with Section 260533.16 "Boxes and Covers for Electrical Systems"]** **<Insert description>**. Master-control cover plate must be one piece.

- E. Master controller must include the following:
1. Cover-mounted switches, including master off, all bright, and selectors for each scene.
 2. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
 3. Concealed switches and indicators for specified function.
 4. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
 5. Fade time indicated by digital display for current scene while fading.
 6. Cover-mounted infrared receiver.
- F. Infrared Transmitters: Wireless remote control for recalling [each] [four] <Insert number> of the presets. Operate up to **50 ft.** within line of sight of the master controller.

2.3 MULTIPRESET MODULAR DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of the following:
1. Master controller.
 2. Dimmer panels[, and indicated number of zone stations].
 3. Controls and dimmers must be integrated for mounting in a multigang wall box under a single wall plate.
 4. Each zone must be adjustable to indicated number of scenes, which must reside in the memory of zone controller.
- B. Dimmers:
1. Each zone must be configurable to control the following loads:
 - a. Fluorescent lamps with [electronic] [magnetic] ballasts.
 - b. LED lamps.
 - c. Incandescent lamps.
 - d. Control-voltage incandescent lamps, derived with [magnetic] [electronic] transformers.
 - e. Non-dim, on-off switching only.
 - f. Neon and cold-cathode lighting.
 - g. <Insert special lighting equipment>.
 2. Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.
- C. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
- D. Device Cover Plates: Style, material, and color [must comply with Section 260533.13 "Boxes and Covers for Electrical Systems"] <Insert description>. Master-control cover plate must be one piece.
- E. Master controller must include the following:
1. Wall-box style, single cover plate supplied by manufacturer.
 2. Cover-mounted switches, including master off, all bright, and selectors for each scene.
 3. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
 4. Concealed switches and indicators for specified function.
 5. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
 6. Fade time indicated by digital display for current scene while fading.

7. Cover-mounted infrared receiver.

F. Remote-Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off. [**Operating the off switch at any remote station must automatically turn on selected housekeeping lighting.**]
3. On switch turns all scenes of master station to full bright.
4. Control Wiring: NFPA 70, Class 2.
5. Mounting: Single flush wall box with manufacturer's [**standard faceplate**] <Insert special material and color for faceplate>.

G. Infrared Remote-Control Station: Same functions as for standard remote-control station except that functions are input by a hand-held infrared transmitter. Operate up to **50 ft.** within line of sight of the master controller.

H. Dimmer Panels: Modular, plug-in type, complying with UL 508.

1. Integrated Short-Circuit Rating: [**10 kA at 120 V**] [, **14 kA at 277 V**].
2. Dimmers:
 - a. Dimming Circuit: Two SCR dimmers, in inverse parallel configuration.
 - b. Dimming Curve: Modified square law as specified in "The Lighting Handbook" from IES; control voltage is zero to 10 V(dc).
 - c. Dimming Range: Zero to 100 percent, full output voltage not less than 98 percent of line voltage.
 - d. Voltage Regulation: Dimmer must maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.

I. Circuit Breakers: Complying with UL 489 and classified as switch duty.

2.4 CONDUCTORS AND CABLES

- A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**No. 18**] [**No. 22**] [**No. 24**] AWG. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING

- A. Wiring Method: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables" and Section 260533.13 "Conduits for Electrical Systems."
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Label each dimmer module with a unique designation.
- C. Label each scene control button with approved scene description.

3.3 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.
- B. Tests and Inspections:
 - 1. Continuity tests of circuits.
 - 2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- C. Nonconforming Work:
 - 1. Dimming control components will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- E. Reports: Prepare written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- F. Manufacturer Services:
 - 1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

END OF SECTION 260936

SECTION 262416.16 - ELECTRONICALLY OPERATED CIRCUIT-BREAKER PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Circuit breakers.
3. Main controllers.
4. Slave panel controllers.
5. Control network.
6. Manual switches and cover plates.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Monitoring:** Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each electronically operated, circuit-breaker panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

- Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
7. Include diagrams for power, signal, and control wiring.
 8. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 9. Submit evidence that electronic controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of network protocol.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Electrically Operated, Molded-Case Circuit Breakers: Equal to **<Insert number>** percent of amount installed [**for each size indicated**], but no fewer than **<Insert number>**.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to [NECA 407] [NEMA PB 1.1].

1.6 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: [Two] **<Insert number>** year(s) from date of Substantial Completion, for labor, materials, and equipment.
 2. Follow-on Extended Warranty Period: [Five] **<Insert number>** year(s) from date of Substantial Completion, for materials that failed because of transient voltage surges only, f.o.b. the nearest shipping point to Project site.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Input signal from field-mounted or on-board signal source must open or close one or more electrically operated circuit breakers in electronically operated, circuit-breaker panelboards. Any combination of inputs must be programmable to any combination outputs.

- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by the authorities having jurisdiction, and marked for intended location and application.
- C. Comply with 47 CFR Part 15, Subpart A and Subpart B, for Class A digital devices.

2.2 PERFORMANCE REQUIREMENTS

- A. Expansion Requirements: Capacity for future expansion of number of control functions by 25 percent of current capacity; to include equipment ratings, housing capacities, spare spaces for circuit breakers, terminals, number of conductors in control cables, and control software.
- B. Interface with DDC System for HVAC: Provide hardware and software to enable DDC system for HVAC to monitor, control, display, and record data for use in processing reports.
 - 1. Hardwired Points:
 - a. Monitoring: On-off status, <Insert monitoring point>.
 - b. Control: On-off operation, <Insert control point>.
 - 2. Communication Interface: Comply with [ASHRAE 135] [ISO/IEC 14908-1] ["MODBUS Application Protocol Specification"] <Insert type of interface> communication interface with DDC system for HVAC must enable DDC system for HVAC operator to remotely control and monitor electronically operated circuit breakers from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at panelboard controller must be available through DDC system for HVAC.

2.3 PANELBOARDS

- A. Electronically operated, circuit-breaker panelboards may contain remotely operated circuit breakers and standard branch circuit breakers specified in Section 262416 "Panelboards."
- B. Assemblies: Comply with UL 67 and NEMA PB 1.
- C. Surge Protective Device:
 - 1. Field mounted, complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Integrally mounted, complying with UL 1449 Type 1.
 - a. Comply with IEEE C62.41, Category C, 200 kA short-circuit current rating.
 - b. Non-modular type with the following features and accessories:
 - 1) Digital-display indicator lights for power and protection status.
 - 2) <Insert features and accessories>.
- D. Enclosures: Comply with UL 50.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by a qualified electrical testing laboratory. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected, short-circuit rating by a qualified electrical testing laboratory.
2. Fully rated to interrupt [10 kA] symmetrical short-circuit current available at terminals.

2.4 CIRCUIT BREAKERS

- A. Remotely operated branch circuit breakers must provide branch circuit overcurrent protection.
- B. Labeled with SWD and HID Ratings: Comply with UL 489 for 15 and 20 A, single-pole branch devices. [15 and 20 A circuit breakers, if scheduled, must be a product of same manufacturer, and be of same class as rated circuit breakers.]
- C. Switching Endurance Rating: Not less than [50,000] [200,000] <Insert number> full-load open/close/open remote operations.
- D. Remotely Operated Circuit Breakers: Manual override switch or handle position must enable or disable remote operation of device and allow breaker handle to manually control breaker's on-off status.

2.5 MAIN CONTROLLERS

- A. Description: Controllers must contain power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.
 1. Comply with UL 916 (CSA C22.2, No. 205); with a microprocessor-based, solid-state, 365-day timing and control unit.
 2. Power Supply: Powered from panelboard, sized to provide control power for operation of remotely operated circuit breakers, controller, bus system, control-voltage inputs, and field-installed sensors.
 3. Integral keypad and digital-display front panel for local setup, including the following:
 - a. Log and display remotely operated breaker on-time.
 - b. Provision to accept downloadable firmware so that latest features may be added in future without replacing module.
 4. Nonvolatile memory must retain all setup configurations. After a power failure, controller must automatically reboot and return to normal system operation.
 5. Ethernet Communications: Comply with [ASHRAE 135] [ISO/IEC 14908-1] ["MODBUS Application Protocol Specification"] <Insert network protocol> protocols.
 - a. Each input connected to controller must control any remotely operated breaker in any other networked electronically operated, circuit-breaker panelboard.
 - b. A schedule programmed at one controller must be able to control any remotely operated breaker in any other networked panelboard.
 6. Time Synchronization: Timing unit must be updated not less than every <Insert number> hour(s) with network time server.
 7. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard Web browser.
 - a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.

- b. Separate Web page, showing status of each main and slave electronically operated, circuit-breaker panelboards with arrangement of breakers on page matching physical appearance of panel. Status must include breaker nametags, pole configuration, location in panel, actual contact state (on-off/tripped/manual), and breaker on-time.
 - c. Panel summary showing master and slave panels connected to controller.
 - d. Controller diagnostic information.
 - e. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.
- 8. Alarm and E-mail Notification: Automatically initiate alarms based on preconfigured conditions listed below and routing alarm alerts as set at control panel.
 - a. General Alarms: Power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of DDC system for HVAC commands.
 - b. Specific Alarms: Input status, zone status, breaker status on-time (zero to 99999 hours).
 - c. E-mail Notification: Automatically route e-mail messages to five individual e-mail addresses. Within body text of e-mail, include a link that will automatically redirect user to associated panels' status Web page.

B. Timing Unit:

- 1. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
- 2. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
- 3. [16] <Insert number> independent schedules, each having [24] <Insert number> time periods.
- 4. Schedule periods settable to the minute.
- 5. Day of week, day of month, day of year with one-time or repeating capability.
- 6. [32] <Insert number> special date periods.

C. With [eight] [16] <Insert number> inputs, each configurable to the following parameters:

- 1. Normally open, normally closed, two-wire maintained toggle, two-wire momentary toggle, two-wire momentary on, two-wire momentary off, or three-wire momentary operation.
- 2. On and off-delay timers for local override operation, adjustable from five minutes to 12 hours. Local override must be by field-installed, two-wire momentary toggle switch.

2.6 SLAVE PANEL CONTROLLERS

- A. Slave panels must contain necessary busses and network hardware to allow connection of sub-net wiring between panels, with programming at main panel controller. Programmable timing unit, Web server, alarm and e-mail notification, and Ethernet connection to control network is not required provided all of these functions are available for slave panel from main panel controller.
- B. Sub-net wiring connections must allow connection of wiring to a terminal that can be removed from panel without interrupting communications to other panels.
- C. Slave panels must contain a nameplate label attached to deadfront trim indicating panel designation, panel network address, and panel designation of associated master panel.

2.7 CONTROL NETWORK

- A. Panel Controllers: Networked with other [electronically operated, circuit-breaker panel controllers] [DDC system for HVAC controllers]

in a peer-to-peer configuration using Ethernet [10Base-T] [100Base-T] network.

- B. Protocol: Controllers must support serial MS/TP and Ethernet IP communications, and must be able to communicate directly via DDC system for HVAC TIA-485 serial networks and Ethernet 10Base-T networks as a native device.

2.8 MANUAL SWITCHES AND COVER PLATES

- A. Keypads: Programmable, designed to control functions associated with equipment of this Section. Units must be able to control any system output device.
- B. Push-Button Switches: Modular, momentary-contact, control-voltage type.
 - 1. Match color specified in Section 262726 "Wiring Devices."
 - 2. Integral green [digital-display] [neon] pilot light to indicate when circuit is on.
 - 3. Internal white [digital-display] [neon] locator light to illuminate when circuit is off.
- C. Manual, Maintained Contact, Line-Voltage or Control-Voltage Switch: Comply with Section 262726 "Wiring Devices."
- D. Cover Plates: Single and multigang cover plates as specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 and Class 3 Control Cables: Multiconductor cable with copper conductors not smaller than [No. 18] [No. 22] [No. 24] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [No. 14] [No. 16] [No. 18] AWG. Comply with Section 260523 "Control-Voltage Electrical Power Cables."
- D. Twisted-Pair Data Cable:
 - 1. [Category 5e] [Category 6] [Category 6a]. Comply with requirements for twisted pair cabling in Section 260523 "Control-Voltage Electrical Power Cables."
 - 2. [Category 5e] [Category 6] [Category 6a]. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to [NECA 407] [NEMA PB 1.1].

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

- A. Wiring Method:
 - 1. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
 - 2. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
 - c. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELBOARDS

- A. Install panelboards and accessories according to **[NECA 407] [NEMA PB 1.1]**.
- B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Mounting Height: **[90 inch]** <Insert dimension> to top of trim above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.

- D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by **[Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>**.

C. Tests and Inspections:

D. Perform the following tests and inspections **[with the assistance of a factory-authorized service representative]**:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

G. Manufacturer Services:

1. Engage factory-authorized service representative to **[support] [supervise]** field tests and inspections.

3.6 STARTUP SERVICE

A. **[Engage a factory-authorized service representative to perform] [Perform]** startup service.

1. Complete installation and startup checks according to manufacturer's instructions.

2. Confirm correct communication wiring, initiate communications between panels, and program control system according to approved time-of-day schedules and input override assignments.
3. <Insert startup steps if any>.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

3.8 MAINTENANCE

- A. Software and Firmware Service Agreement:
 1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for [two] <Insert number> years.
 2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
 - a. Upgrade Notice: No fewer than [30] <Insert number> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
 3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 262416.16

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ~~General-use switches, dimmer switches, and fan-speed controller switches.~~
2. ~~General-grade single straight-blade receptacles.~~
3. ~~General-grade duplex straight-blade receptacles.~~
4. ~~Hospital-grade straight-blade receptacles.~~
5. ~~Receptacles with arc-fault and ground-fault protective devices.~~
6. ~~Locking receptacles.~~
7. ~~Pin-and-sleeve receptacles.~~
8. ~~Special-purpose power outlet assemblies.~~
9. ~~Connectors, cords, and plugs.~~

B. ~~Related Requirements:~~

1. ~~Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.~~
2. ~~Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.~~
3. ~~[Section 013100 "Project Management and Coordination"] <Insert Section number and title> for preinstallation conference procedures.~~
4. ~~Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.~~
5. ~~Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.~~
6. ~~Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.~~
7. ~~Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.~~
8. ~~Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.~~
9. ~~Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.~~
10. ~~Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.~~
11. ~~Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.~~
12. ~~Section 262726.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for additional wiring device products.~~
13. ~~Section 262726.39 "Locking Receptacles" for additional wiring device products.~~
14. ~~Section 262726.41 "Pin-and-Sleeve Receptacles" for additional wiring device products.~~
15. ~~Section 262726.43 "Special-Purpose Power Outlet Assemblies" for additional wiring device products.~~
16. ~~Section 262726.51 "Connectors, Cords, and Plugs" for additional wiring device products.~~

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

- A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

- A. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.
- B. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site]** **<Insert location>**.
- B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting **[as videoconference]** **[or]** **[at Project site]** **<Insert location>** before **<Insert construction activity>**.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect **[, Construction Manager]** **[, and Owner's Commissioning Authority]** of scheduled meeting dates.

1.7 ACTION SUBMITTALS

- A. Product Data:
 - 1. General-use switches, dimmer switches, and fan-speed controller switches.
 - 2. General-grade single straight-blade receptacles.
 - 3. General-grade duplex straight-blade receptacles.
 - 4. Hospital-grade straight-blade receptacles.
 - 5. Receptacles with arc-fault and ground-fault protective devices.
 - 6. Locking receptacles.
 - 7. Pin-and-sleeve receptacles.
 - 8. Special-purpose power outlet assemblies.
 - 9. Connectors, cords, and plugs.
- B. Shop Drawings:
 - 1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.
- C. Samples:
 - 1. One for each kind of toggle switch **[and cover plate accessory]** specified, in each finish and color specified.

2. One for each kind of key lock switch[**and cover plate accessory**] specified, in each finish and color specified.
3. One for each kind of maintained-contact switch[**and cover plate accessory**] specified, in each finish and color specified.
4. One for each kind of momentary-contact switch[**and cover plate accessory**] specified, in each finish and color specified.
5. One for each kind of rocker switch[**and cover plate accessory**] specified, in each finish and color specified.
6. One for each kind of dimmer switch[**and cover plate accessory**] specified, in each finish and color specified.
7. One for each kind of fan-speed controller switch[**and cover plate accessory**] specified, in each finish and color specified.
8. One for each kind of single straight-blade receptacle[**and cover plate accessory**] specified, in each finish and color specified.
9. One for each kind of duplex straight-blade receptacle[**and cover plate accessory**] specified, in each finish and color specified.
10. One for each kind of duplex straight-blade receptacle with integral switching means[**and cover plate accessory**] specified, in each finish and color specified.
11. One for each kind of hospital-grade straight-blade receptacle[**and cover plate accessory**] specified, in each finish and color specified.
12. One for each kind of receptacle with AFCI device[**and cover plate accessory**] specified, in each finish and color specified.
13. One for each kind of receptacle with AFCI and GFCI devices[**and cover plate accessory**] specified, in each finish and color specified.
14. One for each kind of receptacle with GFCI device[**and cover plate accessory**] specified, in each finish and color specified.
15. One for each kind of locking receptacle[**and cover plate accessory**] specified, in each finish and color specified.
16. One for each kind of pin-and-sleeve receptacle specified, in each finish and color specified.
17. One for each kind of cord connector specified, in each finish and color specified.

D. Field quality-control reports.

1.8 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation[**and testing**] instructions issued to Installer by manufacturer for the following:

1. Dimmers.
2. Fan-speed controllers.
3. Single straight-blade receptacles.
4. Duplex straight-blade receptacles.
5. Duplex straight-blade receptacles with integral switching means.
6. Hospital-grade straight-blade receptacles.
7. Receptacles with AFCI device.
8. Receptacles with AFCI and GFCI devices.
9. Receptacles with GFCI device.
10. Locking receptacles.
11. Pin-and-sleeve receptacles.
12. Spring-driven commercial/industrial-use cord reels.
13. Cord reels for use in hazardous locations.

B. Sample warranties.

1.9 CLOSEOUT SUBMITTALS

A. Sustainable Design Closeout Documentation:

1. Record floor plan drawings showing as-installed locations of switches and dimmers, indicating lighting zones each device controls, to verify extent of ability of installed Work to provide occupant control for customizing environment.
2. Record floor plan drawings showing as-installed locations of uncontrolled and marked controlled receptacles superimposed on office furniture layout, to verify extent of ability of installed Work to provide each occupant ability to select at least one uncontrolled receptacle and at least one controlled receptacle for powering workspace equipment. Show locations of UL-approved relocatable power taps and power strips, indicating means of securing for protection from damage and accessibility for inspection. Show locations of temporary extension cords, indicating plan for replacing them with permanent wiring within 90 days.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Extra Keys for Key Lock Switches: [One] <Insert number> of each kind.
 2. SPD Receptacles: Equal to [10] <Insert number> percent of quantity installed for each kind specified, but no fewer than [one] <Insert number> units.
 3. Controlled Receptacles: Equal to [10] <Insert number> percent of quantity installed for each kind specified, but no fewer than [one] <Insert number> units.
 4. Cord Connectors: [One] <Insert number> of each kind.
- B. Special Tools:
 1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.
 2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.11 WARRANTY FOR DEVICES

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
 1. Initial Extended Warranty Period: [Three] [Four] [Five] <Insert number> years from date of Substantial Completion; [full] [prorated] coverage for labor, materials, and equipment.
 2. Follow-On Extended Warranty Period: [Eight] <Insert number> years from date of Substantial Completion; [full] [prorated] coverage for materials[that failed because of transient voltage surges] only, free on board [origin] [destination], freight prepaid.

1.12 WARRANTY FOR CORD REELS

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.
 1. Extended Warranty Period: [Two] [Three] [Four] <Insert number> years from date of Substantial Completion; full coverage for labor, materials, and equipment.

- B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: [Three] [Four] [Five] <Insert number> years from date of Substantial Completion; [full] [prorated] coverage for labor, materials, and equipment.
 2. Follow-On Extended Warranty Period: [Eight] <Insert number> years from date of Substantial Completion; [full] [prorated] coverage for materials[that failed because of transient voltage surges] only, free on board [origin] [destination], freight prepaid.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

- A. Basis for Pricing: <Insert name of manufacturer; model number or series for product that Owner intends to furnish to Contractor>.
- B. Description: <Insert description of product, including special features, options, and finishes for Owner-furnished product that may impact Contractor's installation>.
- C. Accessories: <Insert accessories that will be provided with product>.

2.2 EXISTING PRODUCTS TO BE MODIFIED

- A. Basis for Pricing: <Insert name of manufacturer; model number or series for existing product>.
- B. Description: <Insert description of existing product, including special features, options, and finishes that may impact Work>.
- C. Accessories: <Insert accessories included with existing product>.

2.3 EXISTING PRODUCTS TO BE REMOVED AND RE-INSTALLED

- A. Basis for Pricing: <Insert name of manufacturer; model number or series for existing product>.
- B. Description: <Insert description of existing product, including special features, options, and finishes that may impact Work>.
- C. Accessories: <Insert accessories included with existing product>.

~~2.4 SPECIAL-PURPOSE POWER OUTLET ASSEMBLIES~~

- ~~A. Power Outlet Cord Management Assembly <Insert drawing designation>:~~

- ~~1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.~~
- ~~2. Regulatory Requirements: Components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.~~
- ~~3. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:~~

a. ~~Cord Management System:~~

- 1) ~~Spring-driven commercial/industrial-use cord reel, <Insert wire size> conductors <Insert drawing designation>.~~
- 2) ~~Cord reel for use in Class I Group D hazardous location <Insert drawing designation>.~~

b. ~~Termination Fitting:~~

- 1) ~~Owner-furnished fitting.~~
- 2) ~~Outdoor-use, watertight, sealed cord connector; <Insert NEMA configuration> <Insert drawing designation>.~~
- 3) ~~<Insert title of product> <Insert drawing designation> specified in <Insert Section number and title>.~~

4. ~~Options:~~

- a. ~~Mounting: [Coiling] [Wall] [Floor].~~
- b. ~~<Insert required option>.~~

5. ~~Accessories:~~

- a. ~~<Insert required accessory>.~~

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

A. Private and Open Office Spaces:

1. Uncontrolled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one uncontrolled receptacle is selected for installation not greater than **6 ft** from each workstation.
2. Controlled Receptacles at Workstations: Coordinate final locations of receptacles with furniture plan such that at least one controlled receptacle is selected for installation not greater than **6 ft** from each workstation.
3. Contact Architect for resolution of discrepancies between these requirements and Drawings.

3.3 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
 - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.
- D. Interfaces with Other Work:
 - 1. Coordinate installation of new products for <Insert system or product group> with existing conditions.
 - a. <Insert requirements for transition between new and existing>.
 - 2. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.
 - a. <Insert requirements for transition between this Section and related Work>.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in

NEMA WD 6.

- a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
 - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.
- D. Interfaces with Other Work:
 1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
 2. Coordinate installation of new products for <Insert system or product group> with existing conditions.
 - a. <Insert requirements for transition between new and existing>.
 3. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.
 - a. <Insert requirements for transition between this Section and related Work>.

~~3.6 — INSTALLATION OF LOCKING RECEPTACLES~~

- ~~A. — Comply with manufacturer's instructions.~~
- ~~B. — Reference Standards:~~
 - ~~1. — Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA-NEIS 130.~~
 - ~~2. — Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.~~
 - ~~3. — Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.~~
 - ~~4. — Consult Architect for resolution of conflicting requirements.~~
- ~~C. — Identification:~~
 - ~~1. — Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."~~
 - ~~a. — Mark cover or cover plate using hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.~~

- b. ~~Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.~~

D. ~~Interfaces with Other Work:~~

- 1. ~~Coordinate installation of new products for <Insert system or product group> with existing conditions.~~
 - a. ~~<Insert requirements for transition between new and existing>.~~
- 2. ~~Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.~~
 - a. ~~<Insert requirements for transition between this Section and related Work>.~~

3.7 ~~INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES~~

A. ~~Comply with manufacturer's instructions.~~

B. ~~Reference Standards:~~

- 1. ~~Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.~~
- 2. ~~Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.~~
- 3. ~~Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in UL 1686.~~
- 4. ~~Consult Architect for resolution of conflicting requirements.~~

C. ~~Identification:~~

- 1. ~~Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."~~
 - a. ~~Mark cover or cover plate using hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.~~
 - b. ~~Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.~~

D. ~~Interfaces with Other Work:~~

- 1. ~~Coordinate installation of new products for <Insert system or product group> with existing conditions.~~
 - a. ~~<Insert requirements for transition between new and existing>.~~
- 2. ~~Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.~~
 - a. ~~<Insert requirements for transition between this Section and related Work>.~~

~~3.83.6~~ INSTALLATION OF CORD REELS AND FITTINGS

- A. Comply with manufacturer's instructions.
- B. Special Techniques:
 - 1. ~~<Insert more stringent installation requirements that supplement or supersede manufacturers' instructions>.~~
- C. Interfaces with Other Work:
 - 1. Coordinate installation of new products for ~~<Insert system or product group>~~ with existing conditions.
 - a. ~~<Insert requirements for transition between new and existing>.~~
 - 2. Coordinate with ~~<Insert Section number and title>~~ for ~~<Insert description of interfacing related Work>.~~
 - a. ~~<Insert requirements for transition between this Section and related Work>.~~

~~3.9~~ ~~INSTALLATION OF CONNECTORS, CORDS, AND PLUGS~~

- ~~A. Comply with manufacturer's instructions.~~
- ~~B. Reference Standards:~~
 - ~~1. <Insert system or product group>: Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with <Insert list of standards designations>.~~
 - ~~2. Consult Architect for resolution of conflicting requirements.~~
- ~~C. Special Techniques:~~
 - ~~1. <Insert more stringent installation requirements that supplement or supersede listed standards and manufacturers' instructions>.~~
- ~~D. Interfaces with Other Work:~~
 - ~~1. Coordinate with Section 262726.43 "Special Purpose Power Outlet Assemblies" for installation of connectors and cords on fabricated power-outlet cord management assemblies.~~
 - ~~2. Coordinate installation of new products for <Insert system or product group> with existing conditions.~~
 - ~~a. <Insert requirements for transition between new and existing>.~~
 - ~~3. Coordinate with <Insert Section number and title> for <Insert description of interfacing related Work>.~~
 - ~~a. <Insert requirements for transition between this Section and related Work>.~~

~~3.103.7~~ FIELD QUALITY CONTROL OF SWITCHES

- A. Acceptance Testing Preparation:

1. <Insert requirements>.
- B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.
- C. Tests and Inspections:
 1. Perform tests and inspections in accordance with manufacturers' instructions.
 2. <Insert tests and inspections>.
- D. Nonconforming Work:
 1. Unit will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Assemble and submit test and inspection reports.
- F. Manufacturer Services:
 1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.113.8 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Acceptance Testing Preparation:
 1. <Insert requirements>.
- B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.
- C. Tests and Inspections:
 1. Insert and remove test plug to verify that device is securely mounted.
 2. Verify polarity of hot and neutral pins.
 3. Measure line voltage.
 4. Measure percent voltage drop.
 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
 7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
 8. <Insert tests and inspections>.
- D. Nonconforming Work:
 1. Device will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Assemble and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.12 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Acceptance Testing Preparation:

1. <Insert requirements>.

B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA-NEIS 130 and manufacturers' instructions.
7. <Insert tests and inspections>.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.13 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Acceptance Testing Preparation:

1. <Insert requirements>.

B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Measure line voltage.

3. ~~Measure percent voltage drop.~~
4. ~~Measure ground impedance, which must be not greater than 2 ohms.~~
5. ~~Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA-NEIS 130 and manufacturers' instructions.~~
6. ~~<Insert tests and inspections>.~~

D. ~~Nonconforming Work:~~

1. ~~Device will be considered defective if it does not pass tests and inspections.~~
2. ~~Remove and replace defective units and retest.~~

E. ~~Assemble and submit test and inspection reports.~~

F. ~~Manufacturer Services:~~

1. ~~Engage factory-authorized service representative to [support] [supervise] field tests and inspections.~~

3.143.9 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Acceptance Testing Preparation:

1. ~~<Insert requirements>.~~

B. Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] ~~<Insert names or titles of witnesses>.~~

C. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.
2. ~~<Insert Project-specific test or inspection>.~~

D. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.15 ~~FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS~~

A. ~~Acceptance Testing Preparation:~~

1. ~~<Insert requirements>.~~

~~B. — Field tests and inspections must be witnessed by [Architect] [Tenant] [authorities having jurisdiction] <Insert names or titles of witnesses>.~~

~~C. — Tests and Inspections:~~

- ~~1. — Perform tests and inspections indicated in manufacturer's instructions.~~
- ~~2. — <Insert Project-specific test or inspection>.~~

~~D. — Nonconforming Work:~~

- ~~1. — Unit will be considered defective if it does not pass tests and inspections.~~
- ~~2. — Remove and replace defective units and retest.~~

~~E. — Assemble and submit test and inspection reports.~~

~~F. — Manufacturer Services:~~

- ~~1. — Engage factory-authorized service representative to [support] [supervise] field tests and inspections.~~

3.163.10 SYSTEM STARTUP FOR SWITCHES

A. [Engage a factory-authorized service representative to perform] [Perform] startup service.

1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

3.173.11 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.183.12 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Cord Reels and Fittings:

1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.
- C. Connectors, Cords, and Plugs:
1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- ~~1. Luminaire-mounted photoelectric relays.~~
- ~~2. Luminaire types.~~
- ~~3.1. Materials.~~
- ~~4.2. Finishes.~~
- ~~5.3. Luminaire support components.~~

B. ~~Related Requirements:~~

- ~~1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.~~
- ~~2. Section 260926 "Lighting Control Panelboards" for panelboard-based lighting control.~~
- ~~3. Section 260936 "Modular Dimming Controls" for architectural dimming systems specified in Section 265100 "Interior Lighting."~~
- ~~4. Section 260943.16 "Addressable Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.~~
- ~~5. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.~~

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
1. Arrange in order of luminaire designation.
 2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaire.
 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 5. Photometric data and adjustment factors based on laboratory tests, complying with **[IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project] [IES LM-79] [IES LM-80].**
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Sustainable Design Submittals:
1. BUG Ratings: Product Data indicating BUG ratings of all installed exterior luminaires.
 2. BUG Ratings: Provide luminaire cut sheets indicating backlight, uplight, and glare, based on the specific light source installed at luminaire location.
 3. Luminaire Calculations: Product Data indicating lumen emittance and vertical illuminance.
 4. Product Data: Indicating luminaire is certified by **[ENERGY STAR] [Design Lights Consortium]**.
- D. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- E. Product Schedule: For luminaires and lamps. **[Use same designations indicated on Drawings.]**
- F. Delegated Design Submittals: For luminaire supports.
1. Include design calculations for luminaire supports **[and seismic restraints]**.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Structural members to which **[equipment] [and]** luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.

7. Building features.
 8. Vertical and horizontal information.
 9. <Insert feature>.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, 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. 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. Product Certificates: For each type of the following:
1. Luminaire.
 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by **[manufacturer and witnessed by a qualified testing agency]** **[a qualified testing agency]**.
- F. Source quality-control reports.
- G. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires **[and photoelectric relays]** to include in operation and maintenance manuals.
1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: **[Ten for every 100]** <Insert quantity> of each type and rating installed. Furnish at least one of each type.
 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: **[One for every 100]** <Insert quantity> of each type and rating installed. Furnish at least one of each type.
 3. Diffusers and Lenses: **[One for every 100]** <Insert quantity> of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: **[One for every 20]** <Insert quantity> of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 - 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- E. Mockups: For exterior luminaires, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. <Insert failure modes>.
 - 2. Warranty Period: [2] <Insert number> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance:

1. Luminaires shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
2. Luminaires and lamps shall be labeled vibration and shock resistant.
3. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified [and the luminaire will be fully operational during and after the seismic event]."

2.2 LUMINAIRE 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 [and listed for wet location].
- E. Lamp base complying with [ANSI C81.61] [or] [IEC 60061-1].
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of [minimum] [65] [70] [80] <Insert number>. CCT of [2700 K] [3000 K] [4100 K] <Insert value>.
- H. L70 lamp life of [35,000] [50,000] <Insert number> hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: [120 V ac] [240 V ac] [277 V ac] [12 V dc] [24 V dc].
- L. In-line Fusing: [On the primary for each luminaire] [Separate in-line fuse for each luminaire].
- M. Lamp Rating: Lamp marked for [outdoor use] [and] [in enclosed locations].
- N. Source Limitations:
 1. Obtain luminaires from single source from a single manufacturer.
 2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: [~~Corrosion-resistant aluminum~~] [~~Stainless steel~~] [~~Epoxy-coated steel~~] <Insert material>. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least **0.125 inch** minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.4 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products"

for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] <Insert color>.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color:
 - 1) As selected from manufacturer's standard catalog of colors.
 - 2) Match Architect's sample of [manufacturer's standard] [custom] color.
 - 3) As selected by Architect from manufacturer's full range.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, [and] [canopy ceilings] [and] [overhang ceilings] for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
 - B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
 - C. Install lamps in each luminaire.
 - D. Fasten luminaire to structural support.
 - E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
 - F. Wall-Mounted Luminaire Support:
 - 1. **[Attached to structural members in walls] [Attached to a minimum 1/8 inch backing plate attached to wall structural members] [Attached using through bolts and backing plates on either side of wall] <Insert means of attachment>.**
 - G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
 - H. **[Install luminaires level, plumb, and square with finished grade unless otherwise indicated.] [Install luminaires at height and aiming angle as indicated on Drawings.]**
 - I. Coordinate layout and installation of luminaires with other construction.
 - J. Adjust luminaires that require field adjustment or aiming. **[Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.]**
 - K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems" for wiring connections and wiring methods.
- ### 3.4 INSTALLATION OF BOLLARD LUMINAIRES
- A. Align units for optimum directional alignment of light distribution.
 - 1. Install on concrete base with top **[4 inches]** **<Insert dimension>** above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top **[4 inches]** <Insert dimension> above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with **0.010-inch** thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Photoelectric Control Operation: Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.

- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain luminaires **[and photocell relays]**.

3.10 ADJUSTING

- A. Occupancy Adjustments: When requested within **[12] <Insert number>** months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to **[two] <Insert number>** visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of Architect.

END OF SECTION 265619

SECTION 311000 - 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. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and **[removing site utilities]** **[abandoning site utilities in place]**.
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.2 DEFINITIONS

- A. 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.
- B. 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.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than **2 inches** in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and **[indicated on Drawings]** **[indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."]** **<Insert requirement>**.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program.
- C. Rock stockpiling program.
- D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
- E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.6 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 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. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises [where indicated] <Insert location>.
- D. Utility Locator Service: Notify [utility locator service] [Miss Utility] [Call Before You Dig] [Dig Safe System] [One Call] <Insert name> for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[and plant-protection] measures are in place.
- F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 ~~MATERIALS~~

- A. ~~Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."~~
 - 1. ~~Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.~~
- B. ~~Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [MPI #23 (surface-tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating] <Insert requirement>.~~

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 015639 "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 015639 "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 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. 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.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. 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 Architect not less than **[two]** <Insert number> days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.
- F. 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 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots larger than [2 inches] [3 inches] <Insert dimension> in diameter, obstructions, and debris to a depth of [18 inches] <Insert dimension> below exposed subgrade.
 3. Use only hand methods or air spade for grubbing within protection zones.
 4. Chip removed tree branches and [stockpile in areas approved by Architect] [dispose of off-site] <Insert requirement>.
- 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.
- B. Strip topsoil to depth [indicated on Drawings] [of 6 inches] <Insert requirement> in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to [72 inches] <Insert dimension>.
 2. Do not stockpile topsoil within protection zones.
 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 STOCKPILING ROCK

- A. Remove from [area indicated on Drawings] [construction area] <Insert requirement> naturally formed rocks that measure more than [1 foot] <Insert dimension> across in least dimension. Do not include excavated or crushed rock.
1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- B. Stockpile rock [where indicated on Drawings] [away from edge of excavations] <Insert requirement> without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
1. Limit height of rock stockpiles to [36 inches] <Insert dimension>.
 2. Do not stockpile rock within protection zones.
 3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus rock to allow later use by the Owner.

3.8 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 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. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.
- C. 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 311000