PROJECT MANUAL
for:

Anaheim Tower 7th & 10th Floors Tenant Improvements

North Orange County Community College District
1830 West Romneya Drive
Anaheim, CA  92801

Prepared By:

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March 17, 2017
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Anaheim, CA 92807

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Expiration: 12-31-2017

DATE SIGNED: 03.17.2017
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P2S Engineering, Inc.
5000 East Spring Street, 8th Floor
Long Beach, CA  90815-5218

License:  Mateusz Szlachetka
         M35844
Expiration:  03-31-2018

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         E16124
Expiration:  03-31-2018

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Huntington Beach, CA 92647

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FP1504
Expiration: 6-31-17
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PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 32 00 “Construction Progress Documentation.”
2. Section 01 50 00 “Temporary Facilities and Controls.”
3. Section 01 73 00 “Execution Requirements.”
4. Section 01 74 19 “Construction Waste Management.”

1.2 Summary

A. Project Name: Anaheim Tower 7th & 10th Floors Tenant Improvements.

B. Project Location: 1830 West Romneya Drive, Anaheim, CA 92801.

C. Owner: North Orange County Community College District.

D. Owner's Representative: Mr. Richard Williams, District Director, Facilities Planning/Construction, 1830 West Romneya Drive, Anaheim, CA 92801, 714.808.4893.

E. Architect: R²A Architecture, 2900 Bristol Street, Suite E-205, Costa Mesa, CA 92626, telephone 714.435.0380, fax 714.435.0383, contact Mr. Lucien G. Runge, AIA

F. The work consists of the following:

1. This project consists of tenant improvements to the existing seventh and tenth floors of the Type-1A, fully fire sprinklered, 10-story 202,044 square foot building. Tenant improvements occur in existing seventh and tenth floors, both B-occupancy. Existing restrooms, lobby and elevators to remain unchanged. The remaining seventh floor space will be converted into instructional, classroom and library space totaling 9,588 square feet and the occupancy will remain as B. The remaining tenth floor space will be converted into office space totaling 10,007 square feet and the occupancy will remain as B and A-3.

G. Provide all labor, materials, equipment, freight, taxes, services and administration to complete the work.

H. The Bid Drawings and Specifications indicate the scope of the work in terms of the design concept, the dimensions of the work, and the elements of construction. The Bid Drawings and Specifications do not necessarily indicate or describe all work required for the full performance and completion of the work. Contractor shall be solely responsible for the inclusion of adequate amounts in the bid price to include all items, regardless of whether items are indicated, described, implied, or necessary in order to produce a completed project. Decisions by the Owner’s Representative as to the items of work included within the scope of these Drawings and Contract Documents shall be final and binding on the contractor.

I. By signing this contract, contractor confirms that he has familiarized himself with the conditions of the site and that he has made his own estimates regarding the facilities and the difficulties, which may arise in connection with the execution of the work.
J. By signing this contract, contractor confirms that he has read, reviewed and understands the requirements of all contract documents and that all subcontracted trades have read, reviewed and understand all applicable requirements of the contract documents, including requirements of other trades which may impact each subcontracts portion of work.

K. Contractor shall pay all fees charged by authorities having jurisdiction and from serving utility companies and agencies, for tests and inspections conducted by those authorities, companies and agencies. Owner will reimburse contractor for actual amount of such fees, without mark-up.

1.3 Contract

A. Project will be completed under:


1.4 Use of Premises

A. Contractor shall have full use of premises for construction operations, including use of project site, during construction period. Coordinate use of sight with Owner prior to start of construction. Contractor's use of premises is limited only by Owner's right to perform work or to retain other contractors on portions of project. Perform work so as not to interfere with Owner’s day to day operations. Limit construction operations to the following days and times:

1. Monday through Friday. 7:00 a.m. to 5:00 p.m.

B. Smoking is not permitted within Building or Site, or within 25 feet of entrances, windows or air intakes.

C. Within ten (10) days of date of Notice to Proceed submit written/graphic construction plan describing intended use of construction site. Address the following items:

1. Daily work hours of construction personnel.
2. Parking area for construction personnel and visitors.
3. Staging area.
4. Delivery points.
5. Construction traffic patterns.
6. Construction office location.
7. Temporary toilet location.
9. Maximum number of workers expected in a single day.
10. Crane location.
11. Temporary utility connection location(s)
12. Soil stockpile areas.
13. Construction fencing layouts and pedestrian protection.
15. Trash collection points.
16. Recycled material sorting areas.
17. Scaffold locations.
18. Pedestrian and automobile traffic patterns around site enclosures. Written description and location of protection for people and devices.
19. Identify on the plan surrounding and neighboring uses within a distance of 1,000 feet of the project location.
20. Location of project identification sign.
21. Pedestrian circulation around project site.
22. Order, and sequence of work.
D. Review construction plan with Owner and revise per comments received and resubmit plan along with first payment application. Limit areas of activity as directed by Owner. Copy of plan shall be maintained at project site.

E. Keep driveways and entrances serving premises clear and available to Owner, Owner’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
   1. Schedule deliveries to minimize use of driveways and entrances.
   2. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

F. Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

G. Contractor is aware that adjacent buildings and pedestrian areas are occupied. Contractor must conduct operations to ensure least inconvenience to public and occupied areas in adjacent buildings. Indicate adjacent building occupancy dates in construction schedule and coordinate construction activity with Owner.
   1. Minimum noise impact on adjacent existing occupancies.
   2. Minimum dust and debris impact on adjacent existing buildings and occupancies.
   3. Maintain and provide pedestrian barricades and protection.
   4. Maintain and protect exits from occupied areas at all times.

H. Arrange and pay for parking needed for contractors, workers, subcontractors and employees.

I. Arrange and pay for additional work areas as needed.

J. Access to and egress from construction site shall be in strict conformance with Owner’s requirements and City requirements. Obtain approval for construction routes from Owner and City agencies. Damage to Owner’s landscaping, paving and utilities due to contractor’s use of access route shall be repaired or replaced, as determined by and to the satisfaction of Owner, to match construction of temporary access at no additional cost or time to Contract.

K. Prior to commencement of work, the contractor shall jointly survey, photograph and video tape the site, and all other pertinent items with the Owner, noting and recording existing damage such as cracks, sags, and other damage to existing facilities.
   1. This record shall serve as a basis for determination of subsequent damage to these items due to contractor’s operations.
   2. Existing damage observed shall be marked and documented in a report to the Owner and the report of existing damage shall be signed by Owner and contractor and submitted to the Owner prior to start of work.
   3. Damage to the site, and other items not noted in the original survey but subsequently observed shall be reported immediately by contractor to the Owner.
   4. Contractor shall not unreasonably encumber the site with materials or equipment.
   5. Contractor shall assume full responsibility for protection and safekeeping of products stored on the premises.
   6. Contractor shall move any stored products which interfere with operations of Owner or contractors performing work under separate contracts for Owner.
   7. Temporary closures or restrictions of use of public thoroughfares, necessary to accomplish the Work, shall be made only as approved in advance by public safety and parking authorities having jurisdiction, as directed by Owner.
8. Access to and egress from project area shall be in strict conformance to prearranged routes approved by Owner and jurisdictional authorities, with the understanding that curtailment of construction traffic or revision of access routes may be required on short notice if Owner’s operations mandate such changes because of excessive noise or problems of safety, service or supply.

L. Provide pathways, drives, gates, directional signage and other provisions as required by authorities having jurisdiction for emergency access and egress to project area and adjoining facilities.

M. Contractor shall be completely responsible for safety and security of the work site. Contractor shall keep all tools, equipment and building materials in locations where they will not be accessible to public and to vandals, so as not to present safety or security problems at work site.

N. 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 Owner not less than 72 hours in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner’s written permission.

1.5 Owner’s Occupancy Requirements

A. Owner reserves the right to place and install equipment in completed areas of work, before Substantial Completion, provided such installation does not interfere with completion of the work. Such placement of equipment shall not constitute acceptance of the work, or substantial completion.

1.6 Work Not in Contract

A. The following will be provided by the Owner under separate contracts.
   1. Encapsulation, removal and disposal of any hazardous materials on the site or in the existing Buildings.
   2. Tests and inspections specified to be provided by the Owner in the Contract Documents.
   3. Items noted NIC (Not in Contract) on the Drawings or in the Specifications.

B. When work of this Contract requires the contractor to make allowance for interfacing his work with other work indicated as NIC, the contractor shall include all costs associated therein.

1.7 Documents

A. The Contract Drawings and Specifications are not intended to be comprehensive directions on how to produce the work. Rather, the Drawings and Specifications are instruments of service prepared to generally describe the design intent for the completed work.

B. It is intended that all equipment, systems and assemblies be complete and fully functional even though not fully described. Provide all products and operations necessary to achieve the design intent described in the Contract Documents.

C. Contractor shall report to Architect immediately when elements essential to proper execution of the work are discovered to be missing or misdescribed in the Drawings and Specifications or if the design intent is unclear.
D. Should an obvious omission or misdescription of a necessary element be discovered and reported after execution of the Contract, contractor shall provide the element as though fully and correctly described, and a no-cost no-time Change Order shall be executed.

E. The documents 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. Language used in the Specifications and other Contract Documents is abbreviated. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications and Drawings. Requirements expressed in the imperative mood are to be performed by contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by contractor or by others when so noted.
   a. 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.
   b. Where the terms “as shown,” “as indicated,” “as noted,” “as installed,” “as scheduled,” or terms of like meaning are used in the Drawings or Specifications, it shall be understood that reference is being made to Drawings listed in the Drawing index.
   c. Where reference to the word “plans” is made anywhere in Drawings, Specifications and related Contract Documents, it shall be understood to mean the Drawings listed in the Drawing index in the set of Drawings.

F. Unless stated in the Contract Documents, technical words and abbreviation contained in the Contract Documents are used in accordance with commonly understood construction industry meanings; and non-technical words and abbreviations are used in accordance with their commonly understood meanings.

G. Contract Documents may omit modifying words such as “all” and “any,” and articles such as “the” and “an,” but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement. Use of the word “including,” when following any general statement, shall not be construed to limit such statement to specific items or matters, whether or not non-limiting language (such as “without limitation,” “but not limited to,” or words of similar import) is used with reference thereto, but rather shall be deemed to refer to all other items or matters that could reasonably fall within the broadest possible scope of such general statement.

H. Whenever context so requires, use of the singular number shall be deemed to include the plural and vice versa.

1. Each gender shall be deemed to include any other gender, and each shall include corporation, partnership, trust or other legal entity whenever context so requires.

2. Captions and headings of various subdivisions of Contract Documents are intended only as a matter of reference and convenience and in no way define, limit, or prescribe the scope or intent of Contract Documents or any subdivision thereof.

I. Dates indicated on each Drawing and on each page of the Specifications and other Bidding and Contract Documents in the Project Manual are for identification only. Such dates are not intended to correspond with the date of issue or Contract date.

1.8 Contractor Acknowledgement

A. Contractor acknowledges that Architect’s office hours are Monday through Thursday 7:30 a.m. to 5:30 p.m. and Friday 7:30 a.m. to 11:30 a.m. Any correspondence, including but not limited to RFI’s,
submittals, change orders, phone calls, memos, letters, etc., received after 5:00 p.m. Monday through Thursday and 11:00 a.m. on Friday’s shall be considered to have been received on the next business day.

PART 2 - Products (Not Used)

PART 3 - Execution (Not Used)

End of Section 01 11 00
SECTION 01 21 00 – Allowances

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 01 40 00 “Quality Requirements.”

1.2 Selection and Purchase

A. Within (30) days after date of Notice to Proceed, advise Architect in writing of the date when final selection of each product or system described by an allowance must be completed to avoid delaying the work.

B. Purchase products and systems selected by Architect from the designated supplier.

1.3 Procedures

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.4 Coordination

A. Coordinate allowance items with other portions of the work. Furnish templates as required to coordinate installation.

1.5 Lump-Sum and Quantity Allowances

A. Include cost of specific products and materials identified under allowance, including taxes, freight, and delivery to project site.

B. Include labor to install in all allowances.

C. Include costs for receiving and handling, overhead and profit, and similar costs related to products and materials identified under allowance as part of the Contract Sum and not part of the allowance.

D. Include cutting losses, tolerances, mixing wastes in allowances.

E. Include costs for product imperfections and replacement.

F. Include costs associated with coordination with Owner’s inspection and testing effort.

G. Costs of services not required by the Contract Documents are not included in the allowance.

H. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted. If requested, prepare unused material for storage by the Owner when it is not economically practical to return the material for credit. If directed, deliver unused materials to the Owner’s storage space. Otherwise, disposal of unused material is contractor’s responsibility.
1.6 Unused Materials

A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

B. Prepare unused material for storage by Owner; deliver unused material to Owner's storage space.

C. Disposal of unused material is Contractor's responsibility.

PART 2 - Products (Not Used)

PART 3 - Execution

3.1 Examination

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 Preparation

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 Schedule of Allowances

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SECTION 01 26 00 - Contract Modification Procedures

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 21 00 “Allowances.”
2. Section 01 29 00 “Payment Procedures.”
3. Section 01 31 00 “Project Management and Coordination.”
4. Section 01 32 00 “Construction Progress Documentation.”
5. Section 01 33 00 “Submittal Procedures.”
6. Section 01 73 00 “Execution Requirements.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 01 78 39 “Project Record Documents.”

C. Title 24, Part 1, Section 4-338.

1.2 Proposal Requests

A. Include within the contractor’s quality assurance program such measures as are needed to assure familiarity of the contractor’s staff and employees with all Contract requirements and these procedures for processing Change Order data.

B. Make submittals through the Architect. Submit the number of copies called for under the various items listed in this Section.

C. Based upon Owner’s request for changes in scope, RFI responses, or other changes, Architect will issue a detailed description, or Field Change Directive (FCD) that may require adjustment to the Contract Sum or Time. If necessary, the description, or FCD will include revised Drawings and Specifications.

1. Proposed Changes issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
2. Within 20 days after receipt of proposed changes, submit a quotation estimating 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 proposed Contractor's Construction Schedule that indicates the effect, if any, of the change to the construction schedule. 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.

1.3 Allowances
A. To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place.

1. Include costs specified as part of the allowance. Provide documentation to substantiate change in allowance cost.
2. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
3. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount.
4. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.4 Change Order Procedures

A. On Owner's approval of a Proposal Request, issue a Change Order for signatures of Owner, Contractor and Architect on form approved by Owner.

B. Change Orders will be dated and numbered in sequence.

C. Each Change Order shall include the following information:

1. DSA Application number.
2. Project Name and Address.
3. A detailed description of the change required, with back-up documentation (Bulletin, Change Order Request, cost data, letters, etc.)
4. The reason for the change.
5. Who requested the change.
6. The dollar amount of each item (add, deduct, or no cost.)
7. Time adjustment if warranted.
8. All necessary back-up information, including sales receipts, time cards, field logs, test results, etc., necessary to justify the amounts of time indicated.

D. The Owner, DSA Inspector, Architect and the construction manager shall review, approve, and sign the Change Order.

E. The construction manager will distribute the required number of copies (minimum of seven) of each Change Order prepared and signed and submitted through the construction manager to the Owner.

1. The Architect will retain one signed copy in his file, will forward the other signed copies to the Division of the State Architect (DSA).
2. The Owner, upon approval, will sign all copies, retain one signed copy for the Owner’s files and return the remaining copies to the construction manager for distribution to the Architect.
   a. All Change Orders must be approved by DSA prior to change being made in the work.
3. All Change Orders must be approved by the Owner’s Board prior to the contractor invoicing the Owner for that change.

PART 2 - Products (Not Used)

PART 3 - Execution (Not Used)

End of Section 01 26 00
SECTION 01 29 00 - Payment Procedures

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 21 00 “Allowances.”
2. Section 01 26 00 “Contract Modification Procedures.”
3. Section 01 31 00 “Project Management and Coordination.”
4. Section 01 32 00 “Construction Progress Documentation.”
5. Section 01 77 00 “Closeout Procedures.”

1.2 Schedule of Values

A. Submit Schedule of Values prior to submittal of initial application of payment within 10 days from date of Notice to Proceed.

B. Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Include the following project identification on the Schedule of Values:

1. Project name and location.
2. Name of Architect.
3. Architect’s project number.
4. Contractor’s name and address.
5. Date of submittal.
6. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
7. 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.
8. Update and submit the Schedule of Values with each Application for Payment.
9. Arrange the Schedule of Values in tabular format with separate columns to indicate the following:
   a. Related specification sections.
   b. Description of work.
   c. Name of subcontractor.
   d. Approved change orders that affect value.
   e. Dollar value.
   f. Total contract sum of base contract.
   g. Total Contract sum with total of approved change orders added it.
   h. Percent complete for each line item as work progresses.

10. Differentiate between items stored on site and items stored offsite. Include evidence of insured or bonded and secure warehousing for items stored offsite.
11. Payment for materials and equipment delivered to the project site but not yet incorporated in the work may be made at the discretion of the Owner. Such materials and equipment must be stored at the project site, properly stacked, crated or boxed and, if necessary, covered or protected from
Applications For Payment

A. Make each Application for Payment consistent with previous applications and payments as certified by Architect and paid for by Owner. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment may involve additional requirements.

B. The date for each progress payment is indicated in the Agreement between Owner and contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Submit Application for Payment to Architect on a day of each month agreed to by Owner, contractor and Architect.

D. Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.

E. Complete every entry on form. Notarize and execute directly on each copy of the pay application itself by a person authorized to sign legal documents on behalf of contractor. Notarization on “loose leaf certificates” is not acceptable. Architect will return incomplete applications without action.

1. Match data on the current Schedule of Values and current Construction Schedule.
2. Include amounts of Approved Change Orders issued before last day of construction period covered by application.

F. Submit 3 (three) signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt. All copies shall include waivers of lien and other required attachments. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. With each Application for Payment, submit waivers and releases from every entity that is lawfully entitled to file a lien arising out of the Contract and related to the work covered by the payment.

1. Submit conditional waiver and release upon progress payment on each item for amount requested in current application, after deduction for retainage, on each item.
2. Submit an unconditional waiver and release on each item for the amount paid in the previous application, prior to deduction for retainage.
3. When an application shows completion of an item, submit conditional waiver and release upon final payment.
4. Owner reserves the right to designate which entities involved in the work must submit waivers.
5. Submit waivers of lien on forms, executed in a manner acceptable to Owner.
6. Within 10 (ten) days of receipt of payment that includes final payment on an item of work, submit an unconditional waiver and release upon final payment for the item.

H. Submit substantiating information, as required to substantiate dollar amounts on Application for Payment.

1. Substantiating information will normally be required only for those portions of work whose completion state cannot be readily determined by observation of the completed work.
2. Provide one copy of substantiating information with each copy of the Application for Payment.

I. Administrative actions and submittals that must precede submittal of first Application for Payment include the following:
1. List of subcontractors.
2. Schedule of Values.
3. Construction Schedule.
5. List of contractor's staff assignments.
7. Copies of building permits.
8. Copies of authorizations and Business Licenses from authorities having jurisdiction in location of work.
10. Minutes from preconstruction meeting.
11. Certificates of insurance and insurance policies.
12. List of subcontracts.

J. After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the work claimed as substantially complete.

1. Include documentation supporting claim that the work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. Reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the work.

K. Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. 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. Warranty and Maintenance information.
11. Record documents.

PART 2 - Products (Not Used)

PART 3 - Execution (Not Used)

End of Section 01 29 00
SECTION 01 31 00 - Project Management and Coordination

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 26 00 “Contract Modification Procedures.”
2. Section 01 29 00 “Payment Procedures.”
3. Section 01 32 00 “Construction Progress Documentation.”
4. Section 01 33 00 “Submittal Procedures.”
5. Section 01 40 00 “Quality Requirements.”
6. Section 01 60 00 “Product Requirements.”
7. Section 01 73 00 “Execution Requirements.”
8. Section 01 77 00 “Closeout Procedures.”

1.2 Definitions

A. RFI: Request For Interpretation by contractor seeking interpretation or clarification of the Contract Documents.

1.3 Coordination

A. Coordinate all construction operations to ensure efficient and orderly installation of each part of the work. Coordinate construction operations that depend on each other for proper installation, connection, and operation. Establish and maintain clear communication between all trades.

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 and to comply with the project schedule.
2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
5. Provide and maintain sufficient crew to manage, supervise, execute and complete the work by the required completion date.
6. Observe work of each subcontractor to monitor compliance with schedule and requirements of the Contract Documents.
7. Report noncompliance to Inspector of Record, with recommendation for changes.
8. Contractor shall notify Owner in writing within 10 days of completion of work installed by Owner under separate contract of the defects or discrepancies that will cause delay or cost to the Contract. Failure to notify the Owner in writing shall constitute acceptance of the work as complying with the Contract and coordinated with contractor’s interface and work to be completed.
9. Maintain a current set of DSA approved drawings, project manual, addenda and FCD’s at the site at all times. In addition, maintain sufficient number of copies of these documents to execute the work.
B. Require each subcontractor to:

1. Coordinate work of his own employees and suppliers.
2. Expedite his work to assure compliance with schedules.
3. Coordinate his work with that of other prime contractors, subcontractors and work by Owner.
4. Prepare sub-schedules to comply with critical path.
5. Monitor schedules as work progresses.

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.

D. Coordinate scheduling and timing of required administrative procedures with construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Time progress meetings to coincide with review of payment applications. Such administrative activities include, but are not limited to, the following:

1. Preparation of 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. Pre-installation meetings.
7. Project closeout activities.
8. Startup and adjustment of systems.
9. Project closeout activities.
10. Monitor order, shipping and delivery of products and materials to assure timely arrival at project site.
11. Communicate with subcontractors to assure necessary labor and equipment is at the project site at time work is needed.

E. Coordinate and check layout and installation of work between all trades. Coordinate and sequence work in a logical manner to minimize impact to work in place.

F. Require all subcontractors to read, understand and comply with all applicable requirements of the contract documents. Review documents with subcontractors to assure they are aware of all applicable requirements and to determine if problems or conflicts exist between contract requirements and subcontractor’s intended work plan. Resolve all issues of material order, workflow, and coordination of subcontractors to the satisfaction of the contract requirements.

G. Carefully read, review and understand all contract documents and promptly issue an RFI in writing noting errors, inconsistencies or omissions found, prior to starting any work.

H. Field verify all dimensions needed for fabricated components.

I. Coordinate construction activities so that operations are carried out with consideration for efficient use of power, water and material.

J. Within 10 (ten) days of the date of Notice to Proceed and prior to submitting first Application of Payment, submit a list of names for the following general contractor staff. List phone numbers, email addresses, fax numbers and any other relevant contact information:

1. Principal in charge.
2. Project manager(s).
3. Project superintendent(s).
4. Key administrative staff.

K. Within 10 (ten) days of Notice to Proceed, contractor shall assemble and submit 3 (three) complete sets of Contract Documents that represent the agreement between Owner and contractor. One set shall be retained and kept up to date by the contractor at the jobsite, one set provided to the Owner and one set provided to the Architect. Identify all documents as “Contract Documents” and indicate date of contract. The sets shall include the following:

1. General Conditions.
2. Supplemental Conditions.
3. Technical Specifications.
4. Drawings.
5. Addenda.

1.4 Submittals

A. Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Include project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
3. Number of Copies: Submit 1 (one) PDF copy of each submittal.

1.5 Project Meetings

A. Schedule and conduct meetings at project site on a regular basis to coordinate the work. Prepare agenda and lead the meeting. Issue meeting minutes to all concerned parties.

1. Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Distribute the agenda to all invited attendees.
3. Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 2 days of the meeting.
4. Those persons designated by the contractor to attend and participate in project meetings shall be deemed authorized to commit the contractor to solutions agreed upon or commitments of the contractor made in the project meetings.
5. The contractor will assign the same person or persons to represent the contractor at the project meetings throughout progress of the work.

B. Schedule preconstruction meeting at a time convenient to Owner and Architect, but no later than 10 working days after the date of the Notice to Proceed. Hold the meeting at project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Authorized representatives of Owner, Architect, and their consultants; contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. All participants at the meeting shall be familiar with project and authorized to conclude matters relating to the work.

2. Discuss items of significance that could affect progress, including but not limited to, the following:
   a. Construction schedule and work plan.
   b. Phasing.
   c. Critical work sequencing and long-lead items.
   d. Designation of key personnel and their duties.
   e. Procedures for processing field decisions and Change Orders.
   f. Procedures for RFIs.
   g. Procedures for Bulletins and Field Change Directives.
   h. Procedures for testing and inspecting.
   i. Procedures for processing Applications for Payment.
   j. Distribution of the Contract Documents.
   k. Submittal procedures.
   l. LEED requirements.
   m. Preparation of Record Documents.
   n. Use of the premises.
   o. Work restrictions.
   p. Owner's occupancy requirements, use of facilities and protection of occupants.
   q. Responsibility for temporary facilities and controls.
   r. Construction waste management and recycling.
   s. Parking availability.
   t. Office, work, and storage areas.
   u. Equipment deliveries and priorities.
   v. First aid and safety procedures.
   w. Security.
   x. Progress cleaning.
   y. Working hours.
   z. Safety program.
   aa. Communication channels and procedures.
   bb. Rules and Regulations governing work.
   cc. Safety procedures.
   dd. Review substrate conditions.
   ee. Review project conditions as required by warranties.
   ff. Special inspections required.
   gg. Punch list procedures.
   hh. Project closeout procedures and requirements.
   ii. As-built requirements.

3. Record and distribute meeting minutes.

C. Conduct prefabrication/pre-installation meetings at project site prior to ordering materials for each activity required to have a prefabrication or pre-installation meeting.

1. 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 and Owner of scheduled meeting dates.

2. Review progress of other construction activities and preparations for the particular activity under consideration, including but not limited to the following:
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Lead time.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written recommendations.

n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.
z. Review substrate conditions.

aa. Review project conditions with manufacturer present as related to and required by warranties.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Distribute minutes of the meeting to each party present and to all other concerned parties.

5. Do not proceed with installation if meeting 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.

6. Obtain written statement on manufacturer’s letterhead that substrate conditions are in compliance with and satisfy manufacturer’s written requirements and warranty requirements.

D. Conduct regular coordination meetings at weekly intervals with subcontractors to coordinate construction activities.

1. In addition to representatives of each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with project and authorized to conclude matters relating to the work.

2. Review and correct 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. Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to 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. Review schedule for next period.
b. Review present and future needs of each entity present, including but not limited the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Work hours.
8) Quality and work standards.
9) Status of correction of deficient items.
10) Field observations.
11) RFIs.
12) Safety programs.

3. Record and distribute minutes of the meeting to each party present and to all other concerned parties.

E. Conduct regular progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. In addition to representatives of Owner, Architect, contractor, any other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with project and authorized to conclude matters relating to the work.

2. Review and correct 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. Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to 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. Review schedule for next period.

   b. Review present and future needs of each entity present, including but not limited the following:

      1) Construction progress and immediate issues.
      2) Overall schedule review and look ahead schedule review.
      3) Status of submittals.
      4) Quality and work standards.
      5) Status of correction of deficient items.
      6) Status of proposal requests.
      7) Status of current unresolved issues.
      8) Field observations.
      9) RFIs and RFI log.
     10) Submittals and submittal log.
     11) Change orders and change order log.
     12) Pending changes.

3. Record and distribute minutes of the meeting to each party present and to all other concerned parties.
F. The Owner’s Representative may call a special meeting at any time during the course of the project. Special project meetings shall include representatives of any members of the project team requested in order to discuss problems and/or solutions that are common to the project.

1.6 Requests For Interpretation (RFIs)

A. Immediately on discovery of the need for interpretation of the Contract Documents, prepare and submit an RFI in the approved form.

1. RFIs shall originate with contractor. RFIs submitted by entities other than contractor will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in the work.
3. Review all RFIs with Inspector of Record and Contract Documents prior to submitting RFI to Architect to assure that necessary information is not in the Contract Documents. No time or schedule extension will be approved for RFIs when information is clearly shown in the Contract Documents.

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

1. Project name.
2. Date.
3. Name of contractor.
5. RFI number, numbered sequentially.
6. Specification Section number and title and related paragraphs, as appropriate.
7. Drawing number and detail references, as appropriate.
8. Field dimensions and conditions, as appropriate.
9. Include contractor's suggested solution. If contractor's solution impacts the Contract Time or the Contract Sum, contractor shall state impact in the RFI. RFIs submitted without solution will be returned unreviewed, and no extension of time will be approved.
10. Contractor's signature.
11. Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
12. Enumerate each page and attachments of RFI with sequential number. Indicate total number of pages on RFI form.

C. Architect will review each RFI and determine action required. RFIs received after 3:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

   a. Requests of Means and Methods.
   b. Requests for approval of submittals.
   c. Requests for approval of substitution of products or alternate 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 RFIs with numerous errors.
   h. RFIs which do not propose a solution.

2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
3. If contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 5 working days after receipt of the RFI response.
D. On receipt of Architect's action, immediately review response and notify Architect within one day if contractor disagrees with response. After acceptance of response, update the RFI log and distribute the RFI response to affected parties.

E. Prepare and maintain a tabular log of RFIs organized by the RFI number. Include the following:

1. Owner and project name.
2. Name of contractor.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.

PART 2 - Products (Not Used)

PART 3 - Execution (Not Used)

End of Section 01 31 00
SECTION 01 32 00 - Construction Progress Documentation

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 26 00 “Contract Modification Procedures.”
2. Section 01 29 00 “Payment Procedures.”
3. Section 01 31 00 “Project Management and Coordination.”
4. Section 01 32 33 “Photographic Documentation.”
5. Section 01 33 00 “Submittal Procedures.”
6. Section 01 40 00 “Quality Requirements.”
7. Section 01 60 00 “Product Requirements.”
8. Section 01 73 00 “Execution Requirements.”
9. Section 01 77 00 “Closeout Procedures.”
10. Section 01 78 39 “Project Record Documents.”

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.

B. CPM: Critical Path Method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall project duration and contains no float.

D. Float: The measure of leeway in starting and completing an activity. Float time belongs to Owner.

E. Major Area: A story of construction, a separate building, or a similar significant construction element.

F. Milestone: A key or critical point in time for reference or measurement.

1.3 Procedures

A. Submit 5 copies minimum of schedule prior to submittal of first Payment Application. Submit schedule large enough to show entire schedule for entire construction period. Submit an electronic copy of schedule in PDF format.

B. Construction Schedule: Submit 5 opaque copies of initial schedule, large enough to show entire schedule for entire construction period. Submit an electronic copy of schedule in PDF format.

C. Daily Construction Reports: Submit 2 copies at weekly intervals.

D. Field Condition Reports: Submit 2 copies at time of discovery of differing conditions.
E. Provide 2 week look ahead at each progress meeting.

1.4 Coordination

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Construction Schedule with the Schedule of Values, Submittals Schedule and payment requests.

1.5 Quality Assurance

A. Contractor shall maintain skilled personnel with experience in Construction Project Management (CPM) scheduling and reporting techniques. Scheduler must have a minimum of two (2) years of experience preparing CPM schedules.

PART 2 - Products

2.1 Submittals Schedule

A. Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates. Coordinate Submittal Schedule with Construction Schedule. Submit concurrently with submittal of Construction Schedule. Include the following:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the work covered.
6. Scheduled date for Architect's final release or approval.

2.2 Construction Schedule

A. Extend schedule from date established for Notice to Proceed to date of Final Completion. Show the following dates and portions of time:

1. Notice to Proceed.
2. Contract Completion Date.
3. Date of Substantial Completion.
4. Start and Finish dates for each Activity.
5. Critical Path.
6. Float Time. Do not sequester float time through strategies such as extending activity durations to consume available float time associated with non critical activities to cause the work to become critical.
7. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
8. Show all contractual milestone dates, fabrication completion dates, delivery dates, lead times, and curing times.
9. Deliverable dates such as submittal approval dates, mockup approval dates, deferred approval dates, testing and inspection dates and all other dates affecting progress of the work.
10. Dates that designated working spaces, storage areas, access, and other facilities to be made available by the Owner.
11. Dates for critical decisions from the Owner.
12. Dates required for Owner-furnished contractor-installed items, and Owner-furnished Owner-installed items.
13. Include a separate activity for each portion of work performed by Owner.
14. Connection and relocation of existing utilities.
15. Connections to or penetration(s) of existing structures.
16. Earliest dates when infrastructure and systems are ready for telecom wiring and low voltage installation.
17. As-built documentation preparation time.
18. Start up and operational testing times and dates.

B. Treat each story or separate area as a separate numbered activity for each principal element of the work.

1. Define and arrange activities so no activity is longer than 10 (ten) days.
2. Include procurement time for long lead items requiring more than 10 (ten) days procurement time, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery. Include procurement time within Activity time.
3. Include review and resubmittal times for submittals. Coordinate submittal review times in Construction Schedule with Submittals Schedule.
4. Include time necessary for startup and testing.
5. Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion. Show substantial completion date.

C. 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. Arrange list of activities on schedule by phase.
2. Include a separate activity for each portion of the work performed by Owner.
3. 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.
   g. Seasonal variations.
   h. Environmental control.
   i. Required inspections.
4. Indicate important stages of construction for each major portion of the work.
5. Include critical milestone dates such as Inspections and Completion dates.

D. For each proposed contract modification that affects contract time, prepare a time-impact analysis to demonstrate the effect of the proposed change on the overall project schedule. Submit analysis with proposed change.

E. Prepare Construction Schedule using a computerized, time-scaled CPM network analysis diagram for the work. Failure to include any work item required for performance of this Contract shall not excuse contractor from completing all work within applicable completion dates, regardless of Owner/Architect approval of the schedule.
1. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
2. Use "one workday" as the unit of time. Include nonworking days and holidays in the schedule.
3. Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities.
4. Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

2.3 Reports

A. Prepare a daily construction report recording the following information concerning events at project site:

1. Equipment at project site.
2. Material deliveries.
3. High and low temperatures and general weather conditions.
4. Accidents.
5. Stoppages, delays, shortages, and losses.
6. Meter readings and similar recordings.
7. Orders and requests of authorities having jurisdiction.
8. Services connected and disconnected.
9. Equipment or system tests and startups.
10. Number of workers on site.
11. Estimated completion date of each activity.
12. Specific problems, if any, with the actions and/or inaction of subcontractors, the Owner, Architect, consulting engineers, or the Contract Documents which are preventing contractor’s work from being properly completed per the schedule.
13. Weather conditions.
14. Subcontractors and trades performing work under the Contract on the Site, and number of workers each and number of hours worked by each worker.
15. Others on the Site performing work for Owner under separate contracts.
16. List of visitors to site, giving name, company or agency affiliation and telephone number.
17. Description of situations and circumstances which could delay normal progress of work or which could be basis of claim for change in Contract Time or Contract Sum.
18. Changes to work and who authorized changes.
19. Comments, as contractor determines are appropriate for project record.
20. Current construction activities and tasks completed.

B. Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions and photographs, together with recommendations.

C. When an event of an unusual and significant nature occurs at the project site, whether or not it is directly related to the work, prepare and submit a report. List chain of events, individuals involved, photographs and written description.

D. Submit daily report to Owner’s Representative by 4:00 p.m. daily on each and every working day.

PART 3 - Execution

3.1 Construction Schedule

A. Within 10 (ten) days of Notice to Proceed conduct pre-scheduling meeting to review methods and procedures related to the contractor’s construction schedule, including, but not limited to, the following:
1. Review software limitations, schedule content and format.
2. Verify qualifications of personnel that will develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones, substantial completion, partial occupancy, and completion dates.
4. Review schedule for work of Owner’s separate contracts.
5. Review time required for review of submittals and re-submittals. Review time requirements for long lead items.
6. Review requirements for tests and inspections by independent testing and inspecting agencies.
7. Review time required for completion of startup procedures.
8. Review procedures for updating schedule.

B. Issue schedule at each regularly scheduled progress meeting. At monthly intervals, update schedule to reflect actual construction progress and activities. Issue updated schedule with each Application for Payment.

C. Distribute copies of construction schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other interested parties.
   1. Post copies in project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules 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.

3.2 Corrective Actions

A. Contractor agrees that whenever it becomes apparent to the Owner from the current monthly updated Contract Baseline Schedule that the contract completion date will not be met, the contractor, within 5 working days, will take corrective actions, at no additional cost or time to Owner, including but not limited to:
   1. The contractor shall prepare a recovery schedule to demonstrate how lost time will be re-couped and how the project will be completed by the original agreed upon completion date. Prior to revising the baseline schedule the recovery schedule shall be approved by the Owner.
   2. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.
   3. Increase the number of working hours per shift, shifts per working day, working days per week, or the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work. This paragraph shall not be construed to permit contractor to violate the work hour restrictions specified in the Contract Documents.
   4. Reschedule activities to achieve maximum practical concurrence of accomplished activities.

B. Should the contractor fail to complete the work per the agreed schedule and requires overtime and/or weekend work and/or holiday work to remedy schedule deficiencies, the contractor will bear all expenses associated with the unscheduled overtime work. In the event the contractor requires unscheduled overtime, the contractor will be required to reimburse the Owner, through deductive change order, for inspection and construction manager support. This requirement is in addition to any specified liquidated damages.

C. Should contractor fail to complete project by completion date and project work time runs past completion date, contractor shall be responsible for all costs and expenses associated with extended work time. Contractor shall reimburse Owner, through deductive change order, cost for professional design fees. This requirement is in addition to any specified liquidated damages.
3.3 Two Week Look-Ahead Schedule

A. At each weekly project meeting and based upon the latest approved schedule, the contractor shall submit a weekly two-week look-ahead schedule with actuals through two days prior to the scheduled meeting. The schedule shall show summary of non-critical activities and each critical activity. In addition, a comparison between the planned versus actual of the preceding activities shall be shown.

End of Section 01 32 00
SECTION 01 32 33 - Photographic Documentation

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 00 “Construction Progress Documentation.”
3. Section 01 40 00 “Quality Requirements.”
4. Section 01 50 00 “Temporary Facilities and Controls.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 73 29 “Cutting and Patching.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 01 78 39 “Project Record Documents.”

1.2 Submittals

A. Submit electronic copies of photographs taken since last progress meeting, at each progress meeting.

B. Identify each set of images on transmittal with the following information:

1. Name of project.
2. Name of contractor.
3. Date stamped by camera.
4. Unique sequential identifier.

C. Submit a complete set of digital image electronic files at completion of project. Identify electronic media with date photographs were taken at time of Substantial Completion. Submit images that have same aspect ratio as the sensor, uncropped.

PART 2 - Products

2.1 Photographic Media

A. Provide images in uncompressed TIFF format, produced by a digital camera with minimum sensor size of 4.0 megapixels, 150 DPI minimum.

PART 3 - Execution

3.1 Construction Photographs

A. Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the work. Photographs with blurry or out-of-focus areas will not be accepted.

B. Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Include date and time in filename for each image.
2. Maintain one set of images on CD-ROM in the field office at project site, available at all times for reference. Identify images same as for those submitted to Architect.

C. Before commencement of the work, take color, digital photographs of project site and surrounding properties, including existing items to remain during construction, from different vantage points.

1. Flag construction limits before taking construction photographs.
2. Take photographs to show existing conditions adjacent to property before starting the work.
3. Take photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Photograph construction and fabrication of all mockups as well as each completed version of mockup and final accepted mockup.

E. Take periodic construction photographs one day before the cutoff date associated with each Application for Payment. Select vantage points to show status of construction, progress and adjacent properties since last photographs were taken.

F. Take photographs of substrate conditions just prior to the start of each portion of the work.

G. Take digital color photographs of entire scope of work at time of Substantial Completion. Submit photographs to Owner and Architect with transmittal.

H. Take color digital photographs of entire scope of work at time of Completion. Submit photographs to Owner and Architect with each transmittal.

End of Section 01 32 33
SECTION 01 33 00 - Submittal Procedures

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 00 “Construction Progress Documentation.”
3. Section 01 40 00 “Quality Requirements.”
4. Section 01 60 00 “Product Requirements.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 73 29 “Cutting and Patching.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 01 78 39 “Project Record Documents.”

1.2 Definitions

A. Action Submittals: Written and graphic information that requires the Architect's review. The submittal will only be “approved” by the submitting contractor. By submitting to the Architect, the submitting contractor has approved his submittal and that of his subcontractor and is requesting that the Architect review the contractor’s approved submittal.

B. Informational Submittals: Written information that does not require Architect's review. Submittals may be rejected for not complying with requirements.

1.3 Submittal Procedures

A. The Contractor shall review, confirm, approve and submit to the Architect with the number of copies of Submittals within 30 (thirty) calendar days of the Notice to Proceed.

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

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the work so processing will not be delayed because of need to review submittals concurrently for coordination. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
3. Make all submittals of related products and materials in groups containing all associated items. Architect may reject partial submittals as incomplete or hold them until related submittals are received.
4. Do not use submittals to obtain review or approval of substitutions and alternate methods.
5. Do not use submittals to obtain review or approval of means and methods.

C. Allow 7 (seven) working days for submittal review, including 7 (seven) working days for each resubmittal, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure by contractor to transmit the contractor approved submittals early enough in advance of lead times, fabrication times or work times to
permit adequate review and processing, including resubmittals in order to complete the work on time. Contractor is advised to make early submittals for long lead items.

1. Allow for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise contractor when the time period for submittal processing must be extended for coordination.

2. If intermediate submittal is necessary, process it in same manner as initial submittal.

3. Allow for review of each resubmittal.

D. The contractor shall place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Provide a space approximately 6 x 8 inches on label or beside title block to record action taken by Architect during the review process.

3. Include the following information on label for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name and address of Architect.
   d. Name and address of contractor.
   e. Name and address of subcontractor.
   f. Name and address of supplier.
   g. Name of manufacturer.
   h. Submittal number or other unique identifier, including revision identifier. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
   i. A statement certifying that the submitting contractor has distributed the complete set of construction documents and specifications to his vendor/suppliers for their use in preparing their submittal for the contractor’s approval. The construction documents are not considered dividable. Contractor should be aware that there may be requirements for his trades distributed throughout the construction documents and shall review the entire set with his subcontractors to ensure their scope of work is examined thoroughly as it relates to every sheet of the construction documents.

E. Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals. Provide a written statement as to the nature of the deviation including specific reasons why this is proposed.

F. Contractor shall document and explain all proposed deviations from reference standards and building code research report requirements as well as manufacturer’s product installation instructions and recommendations, including acknowledgement by the manufacturer that such deviations are acceptable with warranty requirements and are appropriate for the project. Contractor to provide a statement of code compliance for the submittal.

G. Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Coordinate submittal of related items. Do not group unrelated submittals from different specification sections under a single transmittal and single submittal number; such submittals will be returned without action. Rejection of one portion of a submittal will be a rejection of the entire submittal. Architect will return submittals, without review, received from sources other than contractor. Use transmittal form approved or supplied by Architect.

H. Clearly mark each copy of each submittal to identify pertinent materials, products, models, options, and other data.
I. Indicate dimensions and clearances required.

J. Supplement manufacturer’s standard data to provide information unique to this project, including dimensions and clearances required, performance characteristics and capabilities, and/or wiring diagrams and controls.

K. Delete information that is not applicable to project.

L. Supplement the standard Drawings to provide additional information applicable to project.

M. Identify and highlight conflicts between manufacturer’s instructions and Contract Documents. If conflict exists, the contractor shall provide the higher cost material, assembly or finish (etc.) at no additional cost to the Owner.

N. 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 identify all revisions.

O. Submit and obtain Inspector of Record’s approval on all submittals prior to distribution of reviewed submittals, ordering or fabricating materials and products.

P. Furnish copies of final submittals with mark indicating Architect’s review action to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

Q. Contractor to utilize final submittals indicating Architect’s ‘review’ or ‘furnish as corrected’ without a requested resubmittal only.

R. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Architect reserves the right to require the contractor to submit additional copies as necessary for enforcement of requirements.

S. Contractor shall maintain complete and current submittal log, indicating status of all submittals and resubmittals. Provide summary of submittal status at each progress meeting and as requested by the Architect.

T. Modify pre-printed data to indicate precise conditions of the project. Comply with requirements as for shop drawings. Provide space for review action stamps and, if required by authorities having jurisdiction, license seal of the contractor’s design professional, as applicable.

U. Provide hard copies of submittals, electronic copies are not acceptable unless approved in writing by the Architect.

V. In addition to the process, documentation and procedures required in this Section, comply with submittal requirements for electrical, mechanical, plumbing, low voltage and communication material and any other product as described in all other specification sections which requires coordination with the contractor’s submittal.

W. Submittals must clearly identify and show compliance with Part 2 of each specification’s section.

1.4 Contractor’s Use of Architect’s CAD Files
A. Contractor is responsible for completing all tasks and pay all associated costs related to the preparation and drafting of all submittals including editing product data, preparing samples and preparation / production of shop drawings. No extended project completion date will be granted for contractor’s lack of timeliness in preparing submittals.

B. As a courtesy to the contractor, the Architect will make available requested CAD files indicating background information for use by contractor in preparation of submittals. Prior to receiving any CAD files from the Architect, contractor will be required to sign a release letter and pay a fee of $150 per drawing sheet.

C. Submittals based upon provided CAD files shall not have any indication referencing the Architect or Owner or Architect’s consultants. Any submittals received bearing such information will be immediately returned without review. Upon submission, the contractor certifies that his submittal meets all applicable codes for its proposed use.

D. Contractor is not allowed to resubmit the Architect’s CAD files, or printed copies of Architect’s drawings for their shop drawings.

PART 2 - Products

2.1 Action Submittals

A. Prepare and submit Action Submittals required by individual Specification Sections.

B. Contractor is responsible for providing complete and thorough information in each submittal so Architect can easily compare submittal information with specified requirements and determine if submitted product qualifies on an “or equal” basis.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. Provide all required information in each submittal so that reviews may be conducted efficiently.

1. If information must be specially prepared for submittal because standard printed data is not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
   a. Manufacturer's written recommendations.
   b. Manufacturer's product specifications.
   c. Manufacturer's installation instructions.
   d. Manufacturer's catalog cuts.
   e. Wiring diagrams showing factory-installed wiring.
   f. Printed performance curves.
   g. Operational range diagrams.
   h. Compliance with specified referenced standards.
   i. Testing by recognized testing agency.

D. Prepare written statement that the submitted material/product fully complies with building code in effect for project and is acceptable to all agencies having jurisdictional control over the project.

E. Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction that the submitted assembly fully complies with all applicable building codes in effect for project and is acceptable to all agencies having jurisdictional control over the project.
1. Submit 1 (one) copy of Product Data in PDF format for review. Architect will return reviewed PDF submittal to project team.

F. Shop Drawings: Prepare project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Dimensions; the contractor is responsible for verifying all dimensions work properly. The Architect will not review the contractor’s dimensions or be responsible for costs to correct the installation.
   b. Identification of products.
   c. Fabrication and installation drawings.
   d. Roughing-in and setting diagrams.
   e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
   f. Shopwork manufacturing instructions.
   g. Templates and patterns.
   h. Schedules.
   i. Notation of coordination requirements.
   j. Notation of dimensions established by field measurement.
   k. Relationship to adjoining construction clearly indicated.
   l. Seal and signature of contractor’s professional engineer as specified and/or as required by the Architect.
   m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
   n. Statement of code compliance for all materials/products and assemblies.

2. 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.

3. Submit 1 (one) copy of each submittal in PDF format for review. Architect will return reviewed PDF submittal to project team.

G. Samples: Submit Samples for review of kind, color, pattern, and texture for a review of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and to be installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Attach label on unexposed side of each Sample that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Submittal number.
   e. Contractor’s approval stamp, date and wet signature.

3. 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.

4. Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
a. Submit 4 (four) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return 2 (two) submittals with options selected.

5. 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.

   a. Submit 4 (four) sets of verification Samples. Architect will return 2 (two).

2.2 Informational Submittals

A. Prepare and submit Informational Submittals required by Specification Sections.

   1. Submit 1 (one) PDF copy of each submittal to the Architect for record keeping only. No action will be taken by the Architect.
   2. Provide a notarized statement that includes signature of entity responsible for preparing certifications. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. The contractor shall provide one copy to the owner, one copy to the IOR and one copy for the project file.

B. Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.

C. Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

D. Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and is authorized by manufacturer for this specific project.

E. Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents and all applicable codes and regulations. Include evidence of manufacturing experience where required.

F. Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents and all applicable codes and regulations.

G. Prepare 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.

H. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

I. Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
J. Prepare written or published information that documents manufacturer's written recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.

K. Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
   2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   3. Results of operational and other tests and a statement of whether observed performance complies with requirements.

L. Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

M. Submit Material Safety Data Sheets (MSDSs) directly to Owner; do not submit to Architect. Architect will not review submittals that include MSDSs and will return them unreviewed for submittal to Owner.

2.3 Delegated Design and Deferred Approvals

A. 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. If criteria indicated are not sufficient to perform design services or certification required, submit written Request for Interpretation (RFI).

B. In addition to Shop Drawings, Product Data, and other required submittals, submit seven (7) copies of a statement, signed and sealed by the contractor's responsible design professional, for each product and system specifically assigned to contractor to be designed or certified by a design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, structural load calculations, and other factors used in performing these services.

C. If any portion of work is designated as a “Deferred Approval” item, provide preparation of design, drawings and calculations to substantiate design in a timely manner so as to not delay or hinder work.
   1. Coordinate “Deferred Approval” items with all other related and interfacing work.
   2. Provide a registered Engineer wet stamp and signature on all drawings and calculations.
   3. Submit design to Architect for review.
   4. After review by Architect, submit to Building Authority and local Fire Official for their approval. Coordinate with governing authorities and manage deferred approval items through plan check / review process and obtain necessary approvals.
   5. Allow for Architect’s review time in the construction schedule.
   6. Allow for Building and Fire Official’s processing time in construction schedule.
   7. Allow for necessary correction time and resubmittals.
   8. Include all printing and distribution costs.

D. Fabrication and installation of deferred approval items shall not be started until detailed plans, specifications and engineering calculations have been reviewed by the Architect and approved by governing authorities.
2.4 Subcontract List

A. Prepare a written summary identifying individuals or firms proposed for each portion of the work, including those who furnish products, equipment or fabrications. Include the following in tabular format:

1. Name, address, telephone number, email and fax number.
2. Number and title of related specification section.
3. License number and grade of license.
4. Submit copies to Architect at time of first application for payment.
5. Retain one returned copy as Record Document. Provide one returned copy to Owner. Provide one returned copy to IOR.

PART 3 - Execution

3.1 Contractor's Approval of His Submittal prior to the Architect's Review

A. Approve each submittal and check for completeness, correctness, coordination with other work of the Contract, compliance with the Contract Documents and to verify that the submittal does not contain information that is a deviation from the requirements of the Contract Documents or requirements of governing authorities, all applicable codes and regulations. Note corrections and field dimensions. Mark each submittal with a wet signed and dated approval stamp before submitting to Architect for the Architect's review.

B. The contractor shall place the contractor’s approval stamp on the index of the body of the submittal, do not place approval stamp on binding cover. Wet sign and date approval stamp. The contents of the submittal shall be tied to the index and every page shall be initialed by the contractor and by his subcontractor. The index shall identify the subcontractor’s and contractor’s initials by name and position within the company.

C. Along with date of contractor's review, provide statement certifying:

1. That submittal has been reviewed and checked for compliance with the Contract Documents.
2. Field measurements have been determined and verified.
3. Conformance with requirements of codes, regulations, standards and design criteria, is confirmed.
4. Product catalog numbers, names and similar data are correct.
5. Work being performed by various subcontractors and trades is coordinated.
6. Field construction criteria have been verified, including confirmation that information submitted has been coordinated with work being performed by others for Owner and with actual site conditions.
7. All proposed deviations from requirements of the Contract Documents have been identified and noted.

D. Submittals not reviewed by the subcontractor and approved by contractor will be returned without action.

E. Submittals containing information that is a deviation or contrary to the requirements of the Contract Documents will be rejected.

3.2 Architect's Action

A. Shop drawings are not part of the Construction Contract Documents (all submittals are of the contractor, by the contractor and for the contractor for their own use in their Work Plan, and for demonstrating their proposed construction means, methods, techniques, sequences and procedures to carry out requirements of the actual Contract Documents).
B. The Architect only reviews the contractor’s approved submittal. The Architect’s review does not constitute approval of this submittal. The review is for the limited purpose of verifying compliance with the specified materials and workmanship (and/or compliance with the reasonably inferable intent) of Architect’s design, as expressed in the Contract Documents. The contractor is responsible for all dimensions of his installation.

C. The shop drawing review is for conceptual compliance and its purpose is not to order quantities or give assembly instructions or protect the contractor or coordinate their subcontractors. The review does not extend to dimensions, quantities, field conditions, coordination of trades, installation instructions, performance of equipment or systems, or for means, methods, sequences or safety procedures of construction unless explicitly stated.

D. Upon submittal, the contractor/supplier certifies that this material/product or assembly meets the California Building Code and all other applicable codes and regulations.

E. Action on a single submittal does not indicate action of an assembly of which the submittal is a component. Action taken in review does not allow or approve deviations from the Contract Documents, unless the deviation is explicitly noted by the contractor and is distinctly accepted separately in writing by the Architect. Full adherence to the contract documents is the sole responsibility of the contractor.

F. The submittal review does not constitute approval of the submittal by the Architect, his employees or agents.

G. Architect will not review submittals that do not bear contractor's approval stamp, wet signature or date and will return them without action.

H. If the Architect returns a submittal as rejected or requiring correction(s) with resubmission, the contractor, so as not to delay the progress of the work, shall promptly thereafter resubmit a submittal conforming to the requirements of the Contract Documents; the resubmittal shall indicate the portions thereof modified in accordance with the Architect’s direction. When professional certification, code compliance, regulation compliance or performance criteria of material, systems or equipment is required by the Contract Documents, the Architect shall be entitled to rely upon the accuracy and completeness of such calculations and certifications accompanying submittals. The Architect’s review of the submittals is for the limited purposes described in the Contract Documents and as outlined in 3.2.A. of this Specifications Section.

I. Architect will review each action submittal, and make comments. Architect will stamp each submittal with a review action stamp and will mark stamp appropriately to indicate the action necessary. Submittals will only be reviewed for conformance with design intent and information in the Contract Documents as outlined in 3.2.A. of this Specifications Section.

J. Architect will retain 1 (one) PDF copy of each informational submittal for record keeping purposes.

K. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

L. Submittals not required by the Contract Documents will not be reviewed and will be discarded.

M. Reviewed submittals will be returned to contractor.

N. Architect will review submittals as originally submitted and for the first resubmission. After two submissions, without successful review of a particular submittal, the contractor will bear the expense through deductive change order for the Architect and his consultants’ review and processing of that submittal. Any new resubmittal to the jurisdictional agency which is required due to the contractor’s non-
compliance with the original Construction Documents or the plan check agency approved Construction Change Document (CCD) will also be the financial responsibility of the contractor.

O. Include all costs for preparing and handling submittals including costs associated with printing and distribution of submittals to a subcontractor.

P. In review of the contractor’s submittals, Architect will not review or provide dimensions or elevations for field conditions, or for proposed conditions available from a detailed review and analysis by contractor of the Contract Documents. The contractor is solely responsible for all coordination of all field dimensions.

Q. Changes in the work shall not be authorized by submittal review actions. No review action, implicit or explicit, shall be interpreted to authorize changes in the work. Changes shall only be authorized by separate written direction, in accordance with the conditions of the Contract. Contractor assumes responsibility for proceeding with work based on reviewed submittals and shall be responsible for all corrections and modifications necessary to bring non-compliant work in compliance with Contract Documents and all applicable codes and regulations at no additional cost or time to Owner. Architect’s review of submittals does not relieve contractor of responsibilities of fully complying with requirements of Contract Documents and requirements of governing authorities and all applicable codes and regulations.

R. Contractor shall review all returned submittals upon receipt from Architect prior to installation by his subcontractor or his company’s labor force.

S. Review actions by Architect and Architect’s consultants shall not relieve contractor from compliance with requirements of the Contract Documents, all applicable codes and regulations.

T. Contractor accepts Architect’s right to ask for additional unspecified submittals as may be required to clarify contractor’s intent to complete the work as indicated.

3.3 Distribution of Submittals after Review

A. After receipt of reviewed submittals, contractor shall distribute one copy of reviewed submittals within three working days of receipt, as follows:

2. Record documents file.
3. Subcontractors.
4. Supplier or fabricator.
5. Other contractors performing work for Owner under separate contracts whose work is affected by information on submittal.
6. Owner’s inspector.
7. Owner’s representative.

End of Section 01 33 00
SECTION 01 40 00 - Quality Requirements

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 33 00 “Submittal Procedures.”
4. Section 01 60 00 “Product Requirements.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 73 29 “Cutting and Patching.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 01 78 39 “Project Record Documents.”

C. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

D. See Divisions 21 through 33 Sections for specific test and inspection requirements.

1.2 Definitions

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the work to evaluate that actual products incorporated into the work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the work will be judged.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the project before products and materials are incorporated into the work to verify performance or compliance with specified criteria.
F. **Product Testing:** Tests and inspections that are performed by a qualified testing agency acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. **Source Quality-Control Testing:** Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. **Field Quality-Control Testing:** Tests and inspections that are performed on-site for installation of the work and for completed work.

I. **Testing Agency:** A professionally licensed entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. **Installer/Applicator/Erector:** Contractor or another entity engaged by contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

K. **“Minimum experience”** means having successfully completed a minimum of five (5) years’ experience on projects similar in size and scope of the type of work required for this project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

L. **IOR:** DSA authorized Inspector of Record.

M. **DSA:** California Division of State Architect.

N. **OAR:** Owner’s Authorized Representative

O. **CBC:** California Building Code, Title 24, California Code of Regulations.

### 1.3 Conflicting Requirements

A. If compliance with two or more standards or code requirements is specified and the standards or code requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most expensive requirement at no additional cost to Owner. When uncertainties exist and requirements are different, but apparently equal, submit RFIs to Architect for a decision before proceeding.

B. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. When uncertainties exist submit RFI to Architect for a decision before proceeding.

C. If contractor is aware of, knows or should have known of conflicts within drawings provide Architect with RFI for clarification and provide more expensive option at no additional cost or time to Contract.

D. If contractor is aware of, knows or should have known of conflicts within specifications provide Architect with RFI for clarification and provide more expensive option at no additional cost or time to Contract.
E. If contractor is aware of, knows or should have known of conflicts between drawings and specifications provide Architect with RFI for clarification and provide more expensive option at no additional cost or time to Contract.

F. If contractor is aware of, knows of or should have known of conflicts between code requirements, authorities having jurisdiction and contract documents provide RFI to Architect for clarification and provide more expensive option at no additional cost or time to Contract.

G. Where the Drawings or Specifications require or describe products or execution of better quality, higher standard or greater size than required by applicable codes, ordinances and standards, the Drawings and Specifications shall take precedence so long as such increase is legal.

H. Where no requirements are identified in the Drawings or Specifications, comply with all requirements of applicable codes, ordinances and standards of authorities having jurisdiction.

I. Where laws, ordinances, rules and regulations require more care or greater time to accomplish work, or require better quality, higher standards or greater size of products, work shall be accomplished in conformance to such requirements with no change to the Contract Time and Contract Sum, except where changes in laws, ordinances, rules and regulations occur subsequent to the execution date of the Contract.

J. Unless more stringent requirements are indicated or specified, comply with manufacturer’s instructions and recommendations, reference standards and building code research report requirements in preparing, fabricating, erecting, installing, applying, connecting and finishing work.

K. In determining “most expensive requirement” and “options” in items “A” through “J” above, consider all factors, such as but not limited to, material cost, order processing, submittal time, delivery time, fabrication labor and time, labor and installation, and affects on overhead and general conditions.

1.4 Certifications and Qualifications

A. For testing agencies retained by contractor, submit proof of qualification 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.

B. Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number 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.
8. Complete test or inspection data.
9. Test and inspection results with interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Name and signature of laboratory inspector.
12. Recommendations on retesting and reinspecting.

C. For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the work.
D. Submit technical data, test reports, calculations, surveys, and certifications based on field tests and inspections by independent inspection and testing agency and by authorities having jurisdiction. Reports of results of inspections and tests shall not be considered Contract Documents.

1.5 Quality Assurance

A. Contractor shall bring together the various parts, components, systems and assemblies as required for the correct interfacing and integration of all elements of work. Contractor shall coordinate work to correctly and accurately connect abutting, adjoining, overlapping and related elements, including work under separate contracts by Owner, utility agencies and companies.

B. Contractor shall provide one person who shall be both knowledgeable and responsible for all work to be performed on this project at all times during normal work hours. Contractor’s appointed representative shall be responsible for all directions given to him and said directions shall be binding as if given to the contractor. Contractor’s representative shall be responsible to coordinate all work to be performed. Do not change contractor’s appointed representative without prior approval of Owner.

C. Provide firms and individuals trained and experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this project, whose work has resulted in construction with a record of successful in-service performance. Provide direct supervision of all workers by supervisors trained and experienced in the type of work being performed. Provide workers performing the actual work that are trained and experienced in the type of work they are being asked to execute.

D. Require each portion of the work to be completed under the direct continuous supervision of a competent foreman, trained and experienced in that portion of work, capable of understanding the Contract Documents and implementing their requirements.

E. All work shall be installed by a knowledgeable contractor and defined “eligible” by the specified materials manufacturers. The specifications and recommendations of the manufacturer whose materials are used shall be strictly adhered to during the application or installation of materials; unless Contract Documents or referenced codes describe more stringent requirements.

F. The contractor shall be responsible for being current and knowledgeable for all building codes involved for all trades under his direction.

G. Provide firms and individuals 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.

H. Provide firms and individuals experienced in producing and fabricating 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.

I. Provide the services of professional engineers who are legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind required. Engineering services are defined as those performed for design and installation of the systems, assemblies, or products that are similar to those indicated for this project in material, design, and extent.

J. Certain sections of the specifications require execution of the work by manufacturer certified installers. Certified installers are to provide supervisors to directly oversee and manage the workers executing the work. Certified installers shall provide supervisors and workers thoroughly trained in the handling and installation of products specified.
K. When required by either Contract Documents or manufacturer's requirements, provide an authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products. Provide manufacturer’s review and inspection to verify that installation satisfies manufacturer’s installation and warranty requirements. If required by manufacturer, provide compensation to manufacturer for costs and expenses of site visits and inspections at no additional cost or time to Contract. Patch and repair any destructive analysis requested and required by manufacturers at no additional cost or time to Contract.

L. Before installing any portions of the actual work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect 7 (seven) days in advance of dates and times when mockups will be completed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Architect's approval of mockups before starting work, fabrication, or construction. Reconstruct mockup as necessary to obtain Architect’s approval.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
6. Construct mockups of identical materials to be used in construction, throughout mockup.
7. Coordinate with all necessary trades to construct mockup to reflect actual construction. Obtain materials, and services and other trades to participate in mockup construction so mockup reflects construction and conditions proposed in finished work, in all respects including but not limited to supporting structure, substrates, flashings, underlayments, attachments, backing and finished materials.
8. Architect’s review and comment, or no comment of mockup, does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work, whether noted or not noted in mockup, are contractor’s responsibility and must be corrected at no additional cost or time to Contract.
9. Demolish and remove mockups that are not included in the work.
10. Use workers trained and experienced in each particular trade required to construct each element of the mockup.
11. Indicate location of all mockups on record drawings.

M. Any additional work beyond that specified or illustrated, or any modifications thereto, that are necessary for the furnishing of required warranty shall be provided by the contractor without additional cost to the Owner.

N. Contract Documents may require that certain construction activities be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and the assignments are requirements over which the contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the contractor. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated. Requirement for specialists shall not supersede building codes and regulations governing the work.

1. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
2. Use of titles such as “carpentry” is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter.” It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
3. Requirement for specialists shall not supersede building codes and similar regulations governing the work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

O. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

P. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion and disfigurement.

Q. Furnish without extra charge any material and labor required in order to comply with jurisdictional authorities, applicable codes and regulations, and referenced standards.

R. Contractor has overall responsibility for all subcontractors, materials suppliers and others providing goods and services to and through the contractor under the Contract.

S. Contractor shall require all subcontractors, trades, crafts and suppliers to coordinate their portion of work with the contractor’s field superintendent to prevent scheduling, sequencing, dimensional and other conflicts and omissions.

T. Contractor shall coordinate and schedule work under the Contract with work being performed for project under separate contracts by Owner, serving utilities and public agencies. Contractor shall make direct contacts with parties responsible for work of the project under separate contracts, in order to provide timely notifications and to facilitate information exchanges.

U. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authority having jurisdiction and shall include all modifications and additions adopted by that authority. The applicable date of laws and ordinances shall be that of the date of performance of the work.

1.6 Quality Control

A. Owner will hire an independent testing agency to conduct tests, sampling, and testing of materials. Selection of material to be tested shall be by the agency or the IOR and not by contractor. Owner will engage a qualified testing agency and special inspectors to conduct special tests and inspections required by authorities having jurisdiction. Special inspections are indicated in the Contract Documents. Procedural and acceptance criteria shall be as set forth in the California Building Standards Administrative Code and as set forth in the California Building Code. Testing and inspections shall meet requirements of CBC 17A.

B. Travel, lodging and meal costs related to any and all off-site material and/or product fabrication testing and/or inspection required by the Contract Documents, DSA, State or Local codes and regulations, in excess of a 50 mile radius from the project site, related to this Contract, shall be paid for by contractor.

C. Owner will directly reimburse testing agency for all costs for all Building or Fire Official required tests and inspections, but may be reimbursed by contractor for such costs as noted in related sections of the Contract Documents.

1. Contractor will reimburse Owner or directly reimburse testing agency for all costs for retesting required by failed tests as set forth in Sections 4-333(c) and 4-335(c) of the California Building Standards Administrative Code.

2. Contractor will reimburse Owner for testing services requested by contractor which are beyond the scope of the work.

D. Independent testing agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the work.
E. Independent testing agency shall not perform any duties of contractor.

F. Contractor shall notify the Owner a sufficient time in advance of the manufacture of material to be supplied by contractor as required under the Contract Documents, which must by terms of the Contract Documents be tested, in order that the Owner may arrange for the testing of same at the source of supply. Contractor will supply and otherwise make materials to be tested available to the testing agency in time to receive results and make necessary corrections and retest, in order to not impact the project schedule.

G. Any material shipped by contractor from source of supply prior to having satisfactorily passed required testing and inspection shall not be incorporated into the work.

H. Where indicated, engage a factory-authorized service representative to inspect substrates, field-assembled components and equipment installation, including service connections. Report results in writing to Owner and Architect.

I. 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 Contract Documents.

J. Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at project site.
8. Make construction materials available to testing agency for testing.

K. Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. Schedule time for tests, inspections, obtaining samples, and similar activities.

1. By advanced discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings. Provide all required time within the construction schedule.
2. When the testing laboratory is ready to test according to the established schedule, but is prevented from testing or taking specimens due to incompleteness of the work, all extra charges for testing attributable to the delay may be back-charged to the contractor and shall not be borne by the Owner.
3. All overtime costs required for testing and inspection shall be paid by Owner and deducted from monies due the contractor.

L. Local legally constituted public authorities having jurisdiction over this construction, the IOR, the Owner and their designated representative shall be the only authorized persons empowered to direct tests to be made when it appears to be necessary to determine compliance or non-compliance to the requirements of the work.

M. Contractor shall assist in all tests and inspections required by authorities having jurisdiction over the work under this Contract, including those required by Division of the State Architect (DSA), Public Works
Department, Fire Department, Health Department and similar authorities having jurisdiction. Such assistance shall include notification of the Project Inspector when the work is ready for inspection or re-inspection.

N. If the contractor elects to change material sources after mix designs, formulations and fabrications have been established, the contractor shall reimburse the Owner for all costs incurred in the re-testing of materials and the re-design and review of mixes, formulations and fabrications.

O. Provide such other testing and inspecting as are specified to be furnished by the contractor in this Section and/or elsewhere in the Contract Documents.

P. Unless otherwise indicated or specified, all products shall be new, free of defects and fit for the intended use.

Q. Contractor shall ensure that products, services, workmanship and site conditions comply with requirements of the Drawings and Specifications by coordinating, supervising, testing and inspecting the work and by utilizing only suitably qualified personnel.

R. When no quality basis is prescribed, the quality shall be in accordance with the best accepted practices of the construction industry for the locale of the project, for similar projects and in compliance with applicable codes, laws, rules and regulations of authorities having jurisdiction.

S. Contractor shall employ and assign knowledgeable and skilled personnel as necessary to perform quality control functions to ensure that the work is provided as required.

T. Contractor shall coordinate and schedule field quality control activities of Owner’s independent testing and inspection agency and inspectors from authorities having jurisdiction. Contractor shall provide 48 hours minimum notice in advance of expected time of operations which require testing and inspection.

U. Work shall be subject to verification of quality by Owner, Architect, other responsible design professionals, authorities having jurisdiction, serving utilities and product manufacturers, in accordance with provisions of the Conditions of the Contract and requirements of product manufacturers.

V. Contractor shall provide all information and assistance necessary for verification of quality, including that by and from subcontractors, fabricators, materials suppliers, manufacturers, installers, applicators and others performing work. Such verification may include observation, inspection and testing at mill, plant, shop or project site locations where products for the work are manufactured, fabricated or assembled.

W. Employment of independent testing laboratory, including Project Inspector, and observations by Owner, Architect and Architect’s consultants shall in no way relieve contractor of duties and responsibilities to perform work in full conformance to all requirements of Contract Documents and applicable Building Code and other regulatory requirements.

PART 2 - Products (Not Used)

PART 3 - Execution

3.1 Testing and Inspection Log

A. Maintain a testing and inspection log at project site. Post changes and modifications as they occur. Provide access to log by Architect, IOR and Owner.

3.2 Repair and Protection
A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

2. Comply with requirements of Section 01 73 29 "Cutting and Patching."

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.

3.3 Test Reports

A. One copy of each test report shall be forwarded directly to Owner, Inspector of Record, Architect, structural engineer, construction manager and contractor by the testing agency. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations as required shall also be reports. Reports shall show that the material or materials were sampled and tested in accordance with the requirements of CBC, Title 24, Parts 1 and 2, and with the approved Contract Documents. Test reports shall show the specified design strength. Test reports shall also state whether or not material or materials tested comply with the specified requirements as set forth in Section 4-335(d) of the California Administrative Code, Title 24.

3.4 Verification of Test Reports

A. Testing agency shall submit to DSA a verified report, in duplicate, covering tests that were performed by that agency during the progress of the work. Additional copies of each test report shall be forwarded directly to Owner, Architect, contractor, project inspector, construction manager, and structural engineer by the testing agency. Such report shall be furnished each time construction on the work is suspended, covering tests up to that time, and prior to Final Completion of the work, covering all tests as set forth in Sections 4-335(e) and 4-336 of the California Administrative Code, Title 24, Part I.

3.5 Site Visitations

A. Owner, Architect and IOR shall have access to the site at all times, to all parts of the work and to all shops/warehouses where materials or work is in preparation, fabrication or storage.

B. Owner, Architect and IOR shall have the right to reject materials and workmanship deemed defective Work, and to require their correction. Rejected work and materials shall be corrected in a satisfactory manner without charge to Owner. If contractor does not correct rejected work within a reasonable time, fixed by written notice and in accordance with the terms and conditions of the Contract Documents, Owner may correct rejected work and recover design, engineering, repair, replacement and administrative costs through deductive change order.

C. The Owner at any time prior to Final Completion reserves the right to make an examination of work already completed by removing work in place. The contractor shall, on request, promptly furnish all necessary facilities, labor, and materials. If work is found to be defective in any respect due to the fault of the contractor all expenses of such examinations and of satisfactory reconstruction will be at the contractor’s expense. If work is found to meet the requirements of Contract Documents, the additional cost of examination and replacement shall be paid for by Owner.
D. Should Architect or Owner determine that it is not feasible or in Owner’s interest to require non-conforming work to be repaired or replaced, and should non-conforming work not be in conflict with the requirements of authorities having jurisdiction, an equitable reduction in Contract Sum shall be made by agreement between Owner and contractor. If equitable amount cannot be agreed upon, a Construction Change Directive will be issued and the amount in dispute resolved in accordance with applicable provisions of the Conditions of the Contract.

E. Contractor is responsible for compliance with all applicable local, state, and federal codes, regulations, ordinances, restrictions, and requirements.

F. Acceptance of non-conforming work, without specific written acknowledgement and approval of the Owner and, as applicable, authorities having jurisdiction, shall not relieve the contractor of the obligation to correct such work. Once discovered, contractor shall correct and modify work to bring it into compliance with Contract Documents at no additional cost or time to Contract.

G. Architect and Architect’s consultants will not accept any work not produced in full conformance with the Contract Documents and the requirements of authorities having jurisdiction, whether known or unknown by Architect or Architect’s consultants.

3.6 Special Inspector

A. Special Inspector:

1. As set forth in Section 4-333(c) of the California Building Standards Administrative Code.
2. As set forth in CBC Section 1701A.5, 1704A.1.

3.7 Inspector of Record

A. Project Inspector of Record (IOR), employed by the Owner in accordance with requirements of California Code of Regulations, Title 24, will be assigned to the work.

1. Project inspector shall be approved by Architect, Structural Engineer, and DSA.
2. As set forth in Section 4-333(b) of the California Administrative Code, Title 24, Part I.
3. Duties of Project Inspector are specifically defined in Section 4-342 of the California Administrative Code, Title 24, Part I.

B. The work shall be subject to the personal continuous observation of the IOR. He shall have free access to any or all parts of the work at any time.

C. Inspection of work shall not relieve contractor from obligation to fulfill all of the terms and conditions of the Contract Documents.

D. Contractor shall be responsible for scheduling times of inspection, tests, sample taking, and similar activities of the work. Provide 48 hour minimum notice to IOR and testing laboratory for tests and inspections.

E. All work must be inspected and approved by IOR prior to being covered by other work.

F. Excessive costs for the Project Inspector beyond normal services shall be charged to the contractor.
3.8 Tests and Inspections

A. The following tests and inspection requirements are based on the 2013 California Building Code, Part 2 of the California Code of Regulations, Title 24, California Building Standards Code, and 2012 International Building Code (IBC) with California Amendments.

B. Required tests and inspections include but are not limited to the following.

1. See CBC, project DSA Testing and Inspections form, and Divisions 21 through 33 Sections for additional information.

C. Steel: CBC, Chapter 22A.

1. Materials:

2. Quality:
   a. Tests of Structural Cold Formed Steel: 2211A.1.

3. Inspection:
   b. Shop Fabrication Inspection: 1704A.2.5.
   c. Welding Inspection: 1705A.2.2.5.

End of Section 01 40 00
SECTION 01 42 00 - References

PART 1 - General

1.1 Related Documents

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

1.2 Definitions

A. Basic Contract definitions are included in the Conditions of the Contract.

B. Approved Equal or Equal: As approved and accepted by the Architect and Owner.

C. Approved: The term “approved” or “approved as noted,” where used in conjunction with action on the submittals, applications, and requests, is limited to the responsibilities and duties of the Architect stated in General Conditions. Such approval shall not release the contractor from responsibility to fulfill Contract Document requirements, unless otherwise provided in the Contract Documents.

D. As Necessary: Essential to completion of work.

E. As Required: As demanded by Contract Documents.

F. As Selected, As Approved, As Directed: Or words of similar import mean as selected by, as approved by, or as accepted by the Architect. No implied meaning shall be interpreted to extend Architect’s responsibility into the contractor’s area of construction supervision.

G. As Shown, As Detailed: And words of similar import mean as indicated on the Drawings.

H. Building Department, Authorities Having Jurisdiction: All agencies, individually or collectively, charged by statute with administration/enforcement of requirements of the Building Code and other jurisdictional requirements at project location.

I. Concealed: Embedded and/or hidden in masonry, concrete or other construction, installed within furred spaces, within a wall/partition or above ceilings, in trenches, in crawl spaces, or other enclosures.

J. Days: Calendar days in every case.

K. Directed: Terms such as “directed,” “requested,” “authorized,” “selected,” “approved,” “required,” and “permitted” mean “directed by the Architect through the construction manager,” “requested by the Architect through the construction manager,” and similar phrases. However, no implied meaning shall be interpreted to extend the Architect’s responsibility into the contractor’s area of construction supervision.

L. Division: Part of these Specifications except where obvious intent is the act or process of dividing. Divisions are groups of related Sections.

M. Equipment: Means a product with operational parts, whether motorized or manually operated, that requires service connections such as wiring or piping.

N. Exposed: Not installed or concealed as defined above.
O. Exterior: A space which does not meet the definition for “interior” above.

P. Fabricated: Items specifically assembled or made out of selected materials to meet individual design requirements for the project.

Q. Furnish: Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.

R. 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."

S. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

T. Installer: An entity engaged by the contractor either as an employee, subcontractor, or sub-subcontractor for performance of a particular construction activity, including installation, erection, application and similar operations. Installers are required to be experienced in the operations they are engaged to perform. The term “experienced,” when used with the term “installer” means having a minimum of five (5) previous projects similar in size and scope to this project, and familiar with the precautions required, and has complied with requirements of the authority having jurisdiction.

U. Interior: A space completely enclosed by walls, solid door(s), floor and ceiling.

V. Manufactured: Applies to standard units or articles usually mass-produced.

W. Manufacturer’s Directions: Manufacturer’s written instructions, recommendations, specifications for use and installation.

X. Materials: Products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form part of work.

Y. Named Products: Items identified by manufacturer’s product name, including make or model designation, indicated in manufacturer’s published product literature current as of the date of the Contract Documents.

Z. Product(s): Materials, systems, and equipment, and terms of similar intent.

AA. Project Site: Space available for performing construction activities. The extent of project site may or may not be identical with the description of the land on which project is to be built.

BB. Provide: Furnish and install, complete and ready for the intended use.

CC. 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.

DD. Section: A distinct part of these Specifications, except where obvious intent is one of several components, a piece. Section is usually a basic unit of work.

EE. Shall: Is mandatory.

FF. Submit, Submittal: Furnish to Architect for review, unless otherwise stated.
GG. Testing Laboratories: An independent entity engaged to perform specific inspections or tests, either at the project site or elsewhere and to report on, and, if required, to interpret, results of those inspections or tests.

1.3 Industry Standards

A. Unless the Contract Documents include more stringent requirements, applicable reference 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. In case of conflict between performance standard or regulation and contract documents provide more expensive requirement at no additional cost to Owner.

B. Comply with referenced standards in effect as of date of the Contract Documents. Referenced standards take precedence over standards that are not referenced but recognized in the construction industry as applicable.

C. Comply with all conditions of approval from governing authorities.

D. In case of conflict between reference standards or reference standards and governing authorities, provide the most expensive requirements, at no additional cost to Owner.

E. The contractual relationship and responsibilities of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

F. Each entity engaged in construction on project shall be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source. Maintain a copy of all applicable regulations and reference standards at the project site.

G. In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Architect for decision before proceeding.

H. Where an alternative or optional grade, class or type of product or execution is included in a reference but is not identified on the Drawings or in the Specifications, provide the highest, best and greatest of the alternatives or options for the intended use and prevailing conditions.

I. Where abbreviations and acronyms are used in Contract Documents, they shall mean the recognized name of the entities in the following list. This list is not inclusive of all organizations.

ACI ACI International (American Concrete Institute)
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute
AITC American Institute of Timber Construction
ANSI American National Standards Institute
APA APA - The Engineered Wood Association
ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM American Society for Testing and Materials International
AWS American Welding Society
CBC California Building Code
CEC California Electric Code
CENC California Energy Code
CFC California Fire Code
CGBS California Green Building Standards
CMC California Mechanical Code
CPC California Plumbing Code
CRSI Concrete Reinforcing Steel Institute
DHI Door and Hardware Institute
FED-STD Federal Standard
FS Federal Specification
ICC-ES ICC Evaluation Service, Inc.
MILSPEC Military Specification and Standards
NES National Evaluation Service (See ICC-ES)
NFPA National Fire Protection Association
NRCA National Roofing Contractors Association
SMACNA Sheet Metal and Air Conditioning Contractors' National Association
TCA Tile Council of America, Inc.
UL Underwriters Laboratory
WI Woodwork Institute

PART 2 - Products (Not Used)

PART 3 - Execution (Not Used)

End of Section 01 42 00
SECTION 01 50 00 - Temporary Facilities and Controls

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 40 00 “Quality Requirements.”
4. Section 01 60 00 “Product Requirements.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 73 29 “Cutting and Patching.”
7. Section 01 74 19 “Construction Waste Management.”
8. Section 01 77 00 “Closeout Procedures.”

1.2 Use Charges

A. Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner’s construction forces, Architect, testing agencies, and authorities having jurisdiction.

B. Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations. Coordinate with owner to determine point of connection.

C. Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations. Coordinate with owner to determine point of connection.

D. Submit temporary utility reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

1.3 Quality Assurance

A. Comply with NECA, NEMA, ANSI A10.6, NFPA 241 and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Comply with industry standards and applicable laws and regulations of the authorities having jurisdiction, including but not limited to:

1. Cal OSHA.
2. Building Code requirements.
3. Health and safety regulations.
4. Utility company regulations.
5. Police, Fire Department and Rescue Squad rules.

D. Refer to “Guidelines for Bid Conditions for Temporary Job Utilities and Services,” prepared jointly by AGC and ASC, for industry recommendations.

E. Contractor is responsible for providing all materials and methods necessary for temporary facilities, controls and protection that are necessary to complete the work.

1.4 Project Conditions

A. Installer of each permanent service shall 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.

B. Provide barricades to protect pedestrian traffic around site.

C. Respond to complaints from Owner within 48 hours.

D. Provide immediate written RFI summarizing complaints received directly from neighbors, adjacent buildings, users or pedestrians.

E. Keep temporary services and facilities clean and neat in appearance. Maintain facilities in good operating condition until removal. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on the site.

F. Contractor is responsible for site, building and individual room security, and security to all areas of work. In the event of loss or damage, promptly restore temporary construction facilities and controls by repair or replacement at no change in the Contract Sum or Contract Time.

1. Provide security program and facilities to protect work from unauthorized entry, vandalism, and theft.

2. At contractor’s discretion, employ guards to protect the site after working hours.

G. Relocate temporary services and facilities as required by progress of the work.

PART 2 - Products

2.1 Materials

A. Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended. Not all materials that may be necessary are listed in this Section.

B. Portable Chain-Link Fencing: Minimum 2-inch, 9 Ga., galvanized steel, chain-link fabric fencing; minimum 6 feet 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 privacy screen in fence and gates. Contractor is responsible for realigning, relocating and reestablishing temporary fence, privacy screen, and gates as required to accommodate access, circulation and progress of work.

C. Provide necessary construction grade lumber and CDX plywood in sizes and thickness needed.

D. Provide half inch regular gypsum board as needed.
E. Provide materials as indicated for temporary construction sign.

F. Provide 10-mil minimum polyethylene sheeting as needed to protect and screen work.

G. Provide paint as needed to comply with VOC requirements.

H. Provide sandbags as required.

I. Provide First Aid supplies. Comply with governing regulations and recommendations of the National Red Cross.

J. Provide security hardware and locks to secure the site and building. Coordinate with Owner on keying requirements and timing for change out.

K. Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.

L. Provide rubber hoses as necessary to serve project site.

2.2 Temporary Enclosures

A. Prefabricated occupiable units with serviceable finishes, lockable entrances, operable windows, heating and air conditioning temperature controls, and foundations adequate for normal loading.

B. Provide storage sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Keep materials dry at all times.

C. Single-occupant self-contained toilet units of chemical, aerated re-circulation or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

D. Provide a mobile contractor’s field office of weather-tight construction, with lighting, power, ventilation, heating and cooling to house contractor.

1. Field office shall have private office for contractor’s superintendent.
2. Field office shall have space for project meetings, with table and chairs to accommodate a minimum of 12 persons.
3. Contractor shall ensure that neither contractor’s field office nor other jobsite facilities are used for living quarters.
4. Contractor’s field office shall present neat, business-like appearance at all times, internally and externally.
5. Provide field office with, but not limited to, the following:
   a. Phone service.
   b. Electrical power.
   c. High speed internet connection.
   d. Computer, fax, telephone, furnishings, etc. for a complete functional environment.

6. Provide trailer skirting, tie-downs, and “fall-stop” seismic anchoring.
7. Provide secure doors and windows. Provide steel security bars on all windows, releasable from inside for emergency egress.
8. Provide blinds on all windows.

E. The contractor shall provide a temporary office for the IOR to be located as directed by the IOR and to be maintained until removal is authorized by the Owner. This office shall be of substantial waterproof construction with adequate natural light and ventilation by means of stock design windows. The door
shall have a deadbolt lock. A table satisfactory for the study of plans and two chairs shall be provided by the contractor. The contractor shall provide and pay for adequate electric lights, private local telephone service with a loud exterior bell with disconnect switch, internet DSL service, fax machine with active line, and adequate heat and cooling for this field office until the completion of the Contract.

2.3 Equipment

A. Provide new equipment suitable for intended use.

B. Provide portable, hand-carried, UL rated fire extinguishers; with class, & extinguishing agent and in quantity & location as required by fire authority. Provide and maintain fire extinguishers in wood construction regardless of Fire Authority requirements. Provide extinguishers for all construction areas, storage areas and enclosures, temporary offices and similar spaces.

C. Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Provide heating units listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV 8 (eight) at each return air grille in system and remove at end of construction. Verify that existing system can drain air through filter without undue stress on existing fans and motors.

D. Locate, place and use equipment so as not to impose excessive loads on supporting walls, floors, roofs and structures.

PART 3 - Execution

3.1 Installation, General

A. Locate temporary facilities where they will serve project adequately and result in minimum interference with performance of the work. Relocate and modify facilities as required by progress of the work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. If contractor’s materials are stockpiled in unapproved areas or creating interference or obstruction with the work of others, or if they are overloading the structure, then at the discretion of the Owner’s representative, the contractor shall be required to relocate these materials at contractor’s expense. If materials are not relocated in the specified time, the Owner reserves the right to move such materials and charge the contractor through deductive change order.

3.2 Temporary Utility Installation

A. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services. Provide 5 day minimum prior notice to Owner of any utility interruptions.

B. Provide temporary utilities to remove effluent lawfully.

C. Provide water service and distribution system in sizes and pressures adequate for construction.
D. Use of Owner's existing water service facilities 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. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.

E. Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

F. Provide temporary ventilation, heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction or existing facilities from adverse effects of high or low temperatures or high or low humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Maintain a minimum temperature of 50°F in permanently enclosed portions of building for normal construction activities, and minimum 65°F for finishing activities and areas where finished work has been installed. Coordinate requirements to produce necessary ambient conditions to meet Contract requirements and minimize energy consumption.

G. Permanent heating and cooling equipment may be used after completion, testing and inspection of systems and approval of code authorities having jurisdiction.

1. Prior to operation of permanent heating equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place.
2. Contractor shall provide and pay for operation, maintenance and regular replacement of filters and worn or consumed parts.
3. Immediately prior to Substantial Completion review, change disposable filters and clean permanent filters of equipment used during construction.

H. Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

I. Provide weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install temporary electric power service underground.

1. Provide properly configured, NEMA-polarized electrical outlets to prevent insertion of 100- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
2. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
3. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.

J. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, emergency exiting and traffic conditions. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system. Provide the following minimum temporary lighting:

1. Provide one 100-W lamp per 500 sq. ft. uniformly distributed, for general lighting, or equivalent illumination.
2. Provide one 100-W lamp every 50 feet in traffic areas.
3. Provide one 100-W lamp per story in stairways and ladder runs, located to illuminate each landing and flight.
4. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility where the work is being performed.

K. Provide temporary telephone service in common-use facilities. Install a minimum of one (1) telephone line for each field office.
   1. Provide a dedicated telephone line for each facsimile machine and computer in each field office.
   2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
   3. Provide one (1) telephone line for IOR office.
   4. Provide temporary electronic DSL communication service, including electronic email in each field office.
   5. Provide temporary electronic DSL communication service, including electronic mail in each IOR office.

3.3 Support Facilities Installation

A. Provide construction offices, shops, and sheds; locate per construction plan. Supply and install a standalone security system which consists of, at a minimum, one electronic entry pad, three (3) motion sensors and both interior and exterior audible horns for the temporary contractor’s field office and the temporary office for the IOR.

B. Erect and install IOR office.

C. Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
   2. Recondition temporary use and road areas, including removing contaminated material, regrading, proofrolling, compacting, and testing.
   3. 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 according to Asphalt Paving Specifications.
   4. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   5. Prepare sub-grade and install sub-base and base for temporary roads and paved areas according to Section 31 23 00 “Earthwork.”

D. Comply with traffic control 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.
   3. Provide Owner and authorities having jurisdiction with a minimum 7 day notice of traffic/street closure and re-routing. Coordinate with all parties concerned on allowable and preferred closure times.
   4. Provide necessary traffic control including flag person. Coordinate with requirements of jurisdictional authority for traffic control requirements.

E. Provide temporary onsite parking areas for construction personnel.
1. Do not park on public roadways unless approved by local police authorities.
2. Maintain clear access ways and parking for emergency vehicles, as required by local police and fire authorities.
3. Keep parking areas clear of construction debris, especially debris hazardous to vehicle tires.

F. Comply with requirements for dewatering and drainage by authorities having jurisdiction. Maintain project site, excavations, and construction free of excess water.
   1. Dispose of rainwater in a lawful manner per requirements of authorities having jurisdiction that will not result in flooding project or adjoining properties nor endanger permanent work or temporary facilities.
   2. Remove snow and ice as required to minimize accumulations.
   3. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
   4. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff or stormwater from heavy rains.
   5. Provide necessary temporary pumps, piping, and filters required to keep excavations dry and free of excess water.
   6. Provide necessary barriers and drainage structures to prevent any surface runoff water from reaching adjacent properties.

G. Provide project identification sign as indicated on drawings and other temporary signs that may be necessary for completion of the work. Locate temporary signs to inform public and individuals seeking entrance to project and warning signs to keep unauthorized people from entering site. Provide additional temporary signs as required by Owner and jurisdictional authorities.
   1. Provide temporary, directional signs for construction personnel and visitors.
   2. Maintain and touchup signs so they are legible at all times.

H. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Locate per construction plan.

I. Provide facilities necessary for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

J. Use of Owner's existing elevators will be permitted, as long as 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. 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 at no additional cost to Owner.

K. Until permanent stairs are available, provide temporary stairs.

L. Use of Owner's existing stairs and roof access ladder will be permitted, as long as stairs and roof access ladder are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work at no additional cost to Owner.
M. Cover finished permanent stairs with protective covering of rosin paper, plywood or similar material so finishes will be undamaged at time of acceptance.

N. Provide street sweeping and clean-up to keep adjacent public ways, streets and sidewalks clean. Clean-up all trash, waste, material and soil debris trails on public ways and streets as a result of the work. Trucks hauling soil, gravel and other loose material must be wetted and covered.

3.4 Security and Protection Facilities Installation

A. Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

B. Comply with Owner’s requirements for using and protecting walk-ways, loading docks, building entries and other building facilities during selective demolition operations.

C. Install temporary fencing located outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

D. Before deep foundation work has been completed, engage pest-control service 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. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

E. Before construction operations begin, furnish and install secure site enclosure fence in a manner that will prevent unauthorized people and animals from easily entering site.

1. Enclose entire project area to accommodate construction operations including office, storage and staging areas and personnel parking.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
3. Provide lockable entrances to work areas to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
4. Provide lockable gates in sizes and locations necessary to complete the work.
5. Contractor shall provide security fencing around complete perimeter of each work area, for the duration of the Contract.
6. Location(s) of security fencing shall be subject to review and approval of Owner prior to erection of fencing. Location of security fencing shall be determined at pre-installation meeting.
7. Time of removal of fencing shall be subject to approval by Owner.

F. Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting. Provide structurally adequate, protective, covered walkway for passage of individuals where hazardous operations may occur overhead.

G. Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures. Coordinate temporary enclosures with material installation, ventilation, drying and curing procedures.

H. Provide floor-to-ceiling temporary dustproof partitions to limit dust and dirt migration and to separate in-use occupied areas from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, over 20 gage metal studs 16” on center with fire-retardant plywood on construction operations side.
2. Insulate partitions to provide noise protection.
3. Seal joints and perimeter.

I. Provide and maintain temporary fire protection facilities of types needed to protect against reasonably predictable fire losses until permanent fire-protection needs are supplied by approved operating facilities. Comply with California Fire Code during all phases of the work.

1. Maintain, at a minimum, the work in conditions to minimize fire hazards and provide adequate fire protection devices, such as suitable fire extinguishers, blankets, warning signs and storage containers.
2. During hazardous construction activities, maintain fire protection devices immediately available for use at the location of such activities.
3. Where existing fire sprinkler system is affected by demolition and re-construction activities, provide either temporary fire protection measures acceptable to governing authorities having jurisdiction or modify existing system as necessary to maintain fire protection. Include extensions and additions to standpipe system, for Fire Department connections.
4. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
5. Store combustible materials in containers in fire-safe locations.
6. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire-exposure areas.
7. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
8. At earliest feasible date in each area of project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
9. Develop and supervise an overall fire-prevention and first-aid fire-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.
10. Provide hoses for fire protection of sufficient length to reach construction areas. 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.
11. 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.

J. Provide guard rails along tops of embankments and excavations. Along public walkways and areas accessible by the public, adjoining excavations, provide guardrails in addition to fencing.

1. Guardrails shall be substantially and durably constructed of umber, firmly anchored by posts embedded in concrete, and complying with Code requirements for temporary barriers.
2. Guardrails shall comply with dimensional requirements and accommodate loads as prescribed by Code for permanent guardrails.
3. Provide guardrails at horizontal openings and deck edges.

3.5 Pollution Controls

A. Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces, public ways and areas.

C. Clean adjacent existing structures, improvements and mechanical systems of dust, dirt, and debris caused by construction operations. Return adjacent areas to condition existing before construction began.

D. Erosion and sedimentation control provisions shall meet or exceed minimum requirements of authorities having jurisdiction. Contractor shall design and provide system to prevent siltation of adjacent property as required by governing authorities having jurisdiction.

1. Implement erosion and sedimentation control provisions prior to commencing site clearing, grading, backfilling and compacting and other construction activities which will expose soil to erosion and potential for sediment-laden runoff.
2. Ensure that sediment-laden water does not enter drainage systems.
3. Maintain erosion and sedimentation control provisions until Substantial Completion review is completed for landscaping, or sooner if approved by authorities having jurisdiction.
4. Implementation, maintenance, replacement and additions to erosion and sedimentation control provisions shall solely be the responsibility of the contractor. As construction progresses and seasonal conditions dictate, more erosion and sedimentation controls may be required. If so, contractor shall provide additional provisions over and above minimum requirements as necessary.

E. Grade site and other work areas to drain:

1. Provide temporary drainage ditches and diversion measures as necessary to protect construction.
2. Provide erosion control measures as necessary and as required by authorities having jurisdiction. Comply with local water quality control requirements, as applicable.

F. Surface runoff and other waters may be encountered at various times during construction. Contractor, by signing the Contract, acknowledges that risks arising from surface runoff and other waters have been investigated and considered, and Contract Sum and Contract Time include all costs associated with runoff control.

1. It shall be responsibility of contractor to protect work from detrimental effects of all waters encountered.
2. It shall be responsibility of contractor to protect work from detrimental effects of runoff.
3. Should damage to the work due to surface or other water occur prior to acceptance of the work by the Owner, contractor shall repair or replace work at no change in Contract Time or Contract Sum.

3.6 Operation, Termination, and Removal

A. Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintain facilities in good operating condition until removal. 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. Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. At earliest feasible time, when acceptable to Owner, change over from use of temporary utilities to use of permanent service.
E. Unless Owner requires temporary facilities and measures be maintained longer; remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of contractor. Owner reserves right to take possession of project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements.
3. Remove temporary underground utility installations to a depth of 2-feet. Backfill, compact and re-grade site as necessary to restore areas or to prepare for indicated paving and landscaping.

3.7 Temporary Utilities Beyond Scheduled Contract Completion Date

A. Electrical power connections and use of building services, such as lighting and HVAC, are imperative for occupancy and operation of facilities by Owner, even if work under the Contract is not completed.

B. If permanent utility services are not complete one week prior to commencement of classes, contractor or contractor’s bonding company shall obtain, connect, monitor, maintain and pay for electrical generators to provide necessary electrical power to power building facilities for Owner’s uses.

1. Electrical generators shall remain operational until permanent power service is completed and operational, in accordance with the Contract Documents and as approved by authorities having jurisdiction, at no additional cost or time to Contract.
2. No additional time will be added to the Contract Time for electrical generators and related components.
3. Contractor shall be responsible for obtaining and paying for permits from authorities having jurisdiction, for operation of electrical generators.
4. Contractor shall remove temporary power service, including generators, the cost of which shall be included in the Contract Sum. No additional time or cost will be added to the Contract for removal of electrical generators and related components.

End of Section 01 50 00
SECTION 01 60 00 - Product Requirements

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 21 00 “Allowances.”
2. Section 01 31 00 “Project Management and Coordination.”
3. Section 01 33 00 “Submittal Procedures.”
4. Section 01 40 00 “Quality Requirements.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 73 29 “Cutting and Patching.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 01 78 23 “Operation and Maintenance Data.”
9. Section 01 78 39 “Project Record Documents.”
10. Section 01 79 00 “Demonstration and Training.”

1.2 References

A. CAL (VOC) – California Department of Health Services Standard Practice for The Testing of volatile Organic Emissions from Various Sources using Small-Scale Environmental Chambers, including 2004 Addenda.

B. GreenSeal GC-03 – Anti-Corrosive Paints; 1997.

C. GreenSeal GS-11 – Architectural Paints; 1993.


1.3 Definitions

A. Products: Items purchased for incorporating into the work. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

B. Substitutions: Are products, materials, equipment, designs and methods of construction that require a deviation from the basis of design requirements of the Contract Documents.

C. Specific manufacturer or product names noted as “or equal” “equal to” or similar language are referenced to establish minimum basis of design requirements for quality, properties, function, dimensions, operating and performance weight, performance, physical properties, appearance, maintenance, wear, warranty, material composition, finishes, color and other characteristics for the purposes of evaluating comparable “or equal” products by other manufacturers. Comply with submittal requirements for submitting products on an ‘or equal” basis. Listed manufacturers are provided as a suggested guide and are not intended to limit contractor’s choices of manufacturers. Contractor is responsible for providing products that meet
the basis of design in every respect and for providing all required information necessary to demonstrate compliance. Provide evidence of compliance with basis of design requirements in required submittal.

D. Descriptive, performance, and reference standard requirements in the Specifications establish “salient characteristics” of products. Where Specifications require compliance with performance requirements, provide products that comply with or exceed requirements, and are recommended by the manufacturer for application indicated. General overall performance of a product is implied where the product is specified for a specific application. Manufacturer’s recommendations may be contained in product literature, or by manufacturer’s certification of performance.

E. Where products are required to match existing in place products, products provided must match existing products in every respect including but not limited to, color, pattern, texture, finish, sheen, size, thickness, weight and attachment method.

1.4 Substitution Request Documentation

A. Submit three copies of each substitution request to the Architect for consideration. Identify product, materials, fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Type written form, acceptable to Architect, showing substitution request identification number, summarize and list each item of content. Include statement on form that contractor has reviewed contents of substitution request and has found it to be in compliance in all respects, and is equivalent to or superior with the requirements of the Contract Documents, including material and installation requirements. Contractor shall sign form stating that the substitution is suited for and can perform the purpose or application of the specified product indicated or specified in the Contract Documents.

2. Show compliance with Contract requirements by providing the following information, as applicable:

a. Statement indicating why specified product or method cannot be provided.

b. Include a detailed description, in written or graphic form as appropriate, indicating all changes or modifications needed to other elements of the work and to construction to be performed by the Owner and by others under separate contracts with Owner, that will be necessary if the proposed substitution is accepted.

c. Detailed side-by-side comparison of significant qualities of proposed substitution with those of the work specified. Mark clearly affected Specification section for any differences from item specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect and specific features and requirements indicated.

d. Provide complete product data, including drawings and descriptions of products and fabrication and installation procedures.

e. Provide samples, where applicable.

f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.

g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

h. Research/evaluation reports acceptable to authority handling jurisdiction, evidencing compliance with building code in effect for project.

i. Detailed evaluation of Construction Schedule showing effect on the overall Contract Time and individual tasks. If specified products are not available from manufacturer within scheduled construction time, provide written statement on manufacturer’s letterhead stating lack of availability or timing of delivery.
j. Cost information including a proposal of change, if any, in the Contract Sum. Substitution requests shall include detailed cost data, including a proposal for the net change, if any, in the Contract Sum.

k. Contractor's certification that proposed substitution complies in every respect with requirements in the Contract Documents is appropriate for applications indicated and has been coordinated with all other Contract requirements and elements of work. Contractor shall wet sign certification; certification shall identify product and specific substitution.

l. 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.

m. Provide same warranty for substitution as for specified product. Warranty shall meet or exceed that for specified product.

n. Substitution requests shall include a signed waiver by the contractor for change in the Contract Time or Contract Sum because of the following:

   1) Substitution failed to perform adequately.
   2) Substitution required changes in other elements of the work.
   3) Substitution caused problems in interfacing with other elements of the work.
   4) Substitution was determined to be unacceptable by authorities having jurisdiction.

o. If, in the opinion of the Architect, the substitution request is incomplete or has insufficient data to enable a full and thorough review of the intended substitution, the substitution may be summarily refused and determined to be unacceptable.

p. Contractor’s request for substitution constitutes a representation that contractor:

   1) Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2) Will provide the same warranty for the substitution as for the specified product.
   3) Will coordinate installation and make changes to other work that may be required for the work to be complete with no additional cost or time to Contract.
   4) Waives claims for additional costs or time extension that may subsequently become apparent.

3. If necessary, Architect will request additional information or documentation for evaluation of a request for substitution. Architect will notify contractor of acceptance or rejection of proposed substitution. Use product specified if Architect cannot make a decision on use of a proposed substitution. Contractor is responsible for providing all necessary information including information requested by Architect to justify substitution.

4. Do not install substituted products without acceptance from Owner and Architect.

5. Do not resubmit rejected substitutions.

6. Use of approved substitution does not alleviate contractor from complying with requirements of Contract Documents.

7. Allow for all substitution request and review times in construction schedule. Additional schedule time will not be granted for substitutions.

1.5 Quality Assurance

A. If contractor is given option of selecting between two or more products for use on project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

B. Do not incorporate products that are provided prior to satisfactorily passing testing requirements.

C. Provide all products required for a complete and proper installation, even if not specifically indicated, at no additional cost to Owner.
D. Where inter-related, multiple components are required for a complete system provide components that are completely compatible and satisfy required warranties. Provide only one brand, kind or make of product from a single source for each purpose throughout work.

E. For all products referred to in singular number, provide the quantity needed to complete the work.

F. Contractor is responsible for providing products that are equal to or better than the level of quality and basis of design specified at no additional cost to Owner.

G. Consider all project requirements when obtaining and supplying products, whether shown in the Contract Documents or not. Consider existing surrounding, neighboring uses, occupancies and functions within 1,000 feet of site before ordering products and materials. Make adjustments to order and provide complete installations compatible with neighboring uses at no additional cost to Owner.

H. Where Contract requires color, texture, or sheen selections to match specific samples or existing conditions, provide colors, textures, and sheen at no additional cost to Owner to match samples or existing conditions specified, even if the use of custom colors, formulations or procedures is necessary to obtain a match to the satisfaction of Architect.

1.6 Product Delivery, Storage, and Handling

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Exercise special care to protect products that are sensitive to light, UV exposure, heat or moisture. Deliver, store, and handle products according to manufacturer’s written recommendations as a minimum.

B. Delivery and Handling:

1. Schedule and sequence deliveries with construction schedule to minimize storage time 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 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. Promptly inspect products on delivery and prior to installation to ensure compliance with Contract Documents and to ensure that products are undamaged and properly protected. Immediately reject and return all products and materials that do not comply.
5. Provide adequate equipment and personnel to properly handle, move and store products and materials to prevent damage, disfiguring or soiling.
6. Pay all demurrage costs associated with delay of deliveries.
7. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
8. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

C. Storage and Protection:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger project structure.
3. Store products that are subject to damage by the elements, under impervious cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer’s written instructions.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, and UV exposure, 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. Comply with MSDS.

7. Protect stored products from damage and liquids from freezing.

8. Do not bring products to site until conditions match those recommended in writing by manufacturer.

9. Do not store products labeled flammable or toxic within the building.

10. Store products in a secure enclosure.

11. When approved by Owner, and when site constraints do not permit on-site storage, materials may be stored off site in a bonded warehouse approved by Owner, at no additional cost to Owner.


13. Arrange storage area to allow access for inspections and for logical sequencing with construction and so materials are placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

14. Periodically inspect to ensure products are undamaged, and are maintained under required conditions.

15. Products damaged by improper storage or protection shall be removed and replaced with new products at no change in Contract Sum or Contract Time.

16. For exterior storage of fabricated products, place products on raised blocks, pallets or other supports, above ground and in a manner to not create ponding or misdirection of runoff. Place on sloped supports above ground.

17. Store with seals and labels intact, legible and exposed to view.

18. Prevent contact with material that may cause corrosion, discoloration, or staining.

19. Provide equipment and personnel to properly deliver, store and handle products by methods to prevent soiling, disfigurement, or damage.

1.7 Product Warranties

A. Warranties specified shall be in addition to manufacturer’s standard warranties or implied 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.

B. Warranty shall be an agreement to repair or replace, without cost and undue hardship to Owner, work performed under the Contract which is found to be defective during the warranty period. Repairs and replacements due to improper maintenance or operation, or due to normal wear, usage and weathering are excluded from warranty requirements unless otherwise specified.

C. Manufacturer’s disclaimers and limitations on product warranties do not relieve the contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the contractor.

D. It is specifically required and acknowledged by this contractor that warranty periods on all work, materials, equipment and products commences from date of Substantial Completion. Therefore, start up of equipment and/or the use of equipment during construction shall not be construed as the qualifier for warranty period start.

E. For equipment and products or components thereof bearing a manufacturer’s warranty that extends for a period of time beyond the contractor’s warranty, so state in the warranty.

F. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
G. When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation, agreed to by Owner.

H. Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefitted from use of the work through a portion of its anticipated useful service life.

I. When a designated portion of the work is completed and occupied or used by the Owner, by separate agreement with the contractor during the construction period, submit properly executed warranties to the Owner within fifteen days of completion of that designated portion of the work.

J. Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such duties, obligations, rights, or remedies.

K. The Owner reserves the right to reject warranties and not limit selections to products with warranties not in conflict with requirements of the Contract Documents.

L. The Owner reserves the right to refuse to accept work for the project where a special warranty, certificate, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.

M. When a warranty is required to be jointly executed by contractor and a subcontractor, or contractor and supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by all required parties. Submit a draft to the Owner for approval prior to final execution.

N. Where special warranties are required prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval as submittal. Even when not specifically indicated as a submittal within a specific Specification Section.

O. All warranties shall indicate the Owner as beneficiary.

P. Provide written indication on each warranty of all requirements of Owner to maintain warranty.

Q. Submit 3 copies of all warranties, guarantees and bonds. Prepare written documents utilizing the appropriate form, ready for execution by the appropriate party(s). Submit a draft to Owner for approval prior to final execution.

   1. Prepare warranty letter on appropriate letterhead, addressed to Owner.
   2. Warranty letters shall be signed by all responsible parties and by contractor in every case, with modifications only as approved in advance by Owner to suit the conditions pertaining to the warranty or guarantee.
   3. Signatures shall be by person authorized to sign warranties, on behalf of entity providing such warranty. All signatures on warrants shall be original wet ink and shall be notarized.

R. Unless otherwise directed or specified, commencement date of warranty periods shall be the date of Substantial Completion.

   1. Warranties for Work Accepted in Advance of Date of Substantial Completion: When a designated system, equipment, component parts or other portion of the work is completed and occupied or put
to beneficial use by Owner, by separate agreement with contractor prior to Substantial Completion date, submit properly executed warranties to Owner within ten days of completion of that designated portion of the work. List date of commencement of warranty period as the date of Substantial Completion.

2. Warranties for Work Not Accepted as of Date of Substantial Completion: Submit documents within ten days after acceptance, listing date of acceptance as beginning of warranty.

S. Unless otherwise specified or prescribed by law, warranty and guarantee periods shall be not less than the warranty period required by the Contract Documents but in no case less than one year from the date established for Substantial Completion.

1.8 Owner Furnished Contractor Installed (OFCI) Items

A. Installation of indicated Owner Furnished Contractor Installed (OFCI) items shall be complete in every detail.

B. Contractor shall verify exact sizes and services required for each item of equipment indicated on Drawings or in project manual as OFCI and shall obtain from Owner, and verify information shown on rough-in drawings, diagrams, setting templates and other necessary information to ensure proper mating of assemblies.

C. Contractor shall receive at project site each item of equipment from Owner and from that time on shall assume full responsibility for items and equipment until one year from date of Substantial Completion.

D. Contractor shall give Owner fifteen (15) days prior notice of requirements for delivery to site of all OFCI equipment.

E. Contractor shall be responsible for receiving OFCI items and equipment and shall uncrate, inspect and notify Owner in writing within one (1) day of receiving, of acceptance or rejection of items or equipment. Owner, after receiving notice, will take appropriate action to have items or equipment made acceptable for contractor's use. Rejected items shall be carefully stored and protected from damage by contractor until Owner takes appropriate action.

F. OFCI items will be delivered to the site by Owner.

G. Store OFCI items in a secured, covered, dry storage area. OFCI items damaged during storage, handling or installation shall be repaired or replaced to the satisfaction of the Owner at the contractor’s expense. Contractor shall open and inspect OFCI items within one day of receipt.

H. Contractor shall be responsible for final placing, installation, connection, start-up, checking, testing and demonstrated satisfactory operation. Owner will provide names of manufacturer’s representatives, who shall assist the contractor in checking, testing and demonstrating equipment.

I. Work under the Contract shall include all provisions necessary to fully incorporate such Owner furnished products into the work, including, as necessary, fasteners, backing, supports, piping, conduit, conductors and other such provisions from point of service to point of connection, and field finishing.

J. Provide installation inspections required by jurisdictional authorities for work that included Owner provided items.

1.9 Owner Furnished Owner Installed (OFOI) Products

A. Provide access to project site for Owner's construction forces.
B. Coordinate construction and operations of the work with work performed by Owner's construction forces.

1. 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. Include Owner's construction forces at pre-installation conferences covering portions of the work that are to receive Owner's work. Attend pre-installation meetings conducted by Owner's construction forces if portions of the work depend on, or are inter-related with Owner's construction.

PART 2 - Products

2.1 Existing Material and Systems

A. Unforeseen historically significant items encountered remain the property of the Owner; notify Owner promptly upon discovery. Do not disturb; protect in place and request disposition of existing materials and systems.

2.2 Product Selection

A. Provide products that comply with the Contract Documents that are undamaged and new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, safety devices, and other items needed for a complete installation and intended use and effect.

2. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

3. ‘Or Equal’ basis-of-design: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product that is equal in all respects. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

4. Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

5. Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, Architect will select color, pattern, density, or texture from manufacturer’s full range of products that includes standard, premium, and custom items.

6. Where a conflict exists between two different products specified to the same piece of work, provide the more expensive product at no additional cost or time to Contract.

7. Where conflict exists between product requirements indicated and jurisdictional requirements provide for more expensive option at no additional cost or time to Contract.

8. Where conflict exists between specifications and drawings for product requirements provide more expensive product at no additional cost or time to Contract.

9. Where products are accompanied by the term “match sample,” sample to be matched is Architect’s.

10. If available, and unless custom products or nonstandard options are specified, provide standard products and types that have been produced and used successfully in similar situations on other projects.

11. All products, other than commodity products prescribed by Code, shall have a current ICBO Evaluation Service (ICBO ES) Research Report or CABO National Evaluation Report (NER).

12. To the fullest extent possible, provide products of the same kind from a single source. Products required to be supplied in quantity shall be the same products and interchangeable throughout the work. When options are specified for the selection of any of two or more products, the products selected shall be compatible with products previously selected.
13. Except for required Code-compliance labels and operating and safety instructions, locate nameplates on inconspicuous, accessible surfaces. Do not attach manufacturer’s identifying nameplates or trademarks on surfaces exposed to view in occupied spaces or to the exterior.

14. Provide a permanent nameplate on each item of service-connected or power-operated equipment. Nameplates shall contain identifying information and essential operating data such as but not limited to, the following example:

   a. Name of manufacturer.
   b. Name of product.
   c. Model and serial number.
   d. Capacity.
   e. Operating and power characteristics.
   f. Labels of tested compliance with Codes and Standards.

15. For each item of service-connected or power-operated equipment, provide operating and safety instructions, permanently affixed and of durable construction, with legible machine lettering. Comply with all applicable requirements of authorities having jurisdiction and listing agencies.

PART 3 - Execution

3.1 Substitution Process Requirements

A. Instructions to bidders specify time restrictions and requirements for submitting requests for substitutions during the bidding period.

B. Submit substitution requests to Architect within 10 (ten) days of bid due date.

C. Architect will consider requests for substitution if received within 30 (thirty) days after date of Notice to Proceed.

D. Requests received after that time may or may not be considered at discretion of Architect.

E. Architect will consider contractor's request for substitution only when all of the following conditions are satisfied:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume, such as Architect’s evaluation, redesign efforts, plan check time, fabrication time, lead time and installation time.

2. Substitutions must clearly be in Owner’s best interest because of quality, cost, performance, conformity to code requirements or availability.

3. Requested substitution does not require extensive revisions to the Contract Documents.

4. Requested substitution is consistent with the Contract Documents and will produce indicated results.

5. Substitution request is timely, fully documented and properly submitted.

6. Requested substitution will not adversely affect contractor's construction schedule.

7. Requested substitution has received necessary approvals of authorities having jurisdiction.

8. Requested substitution is compatible with other portions of the work.

9. Requested substitution has been coordinated by contractor with other portions of the work.

10. Requested substitution provides specified warranties.

11. Substitutions shall, without exception, be manufactured of same basic materials and comply with or exceed all Specification requirements of dimension, non-operating weight, operating weight, function, structure and appearance, without deviation.
F. Contractor is responsible for providing all information necessary and requested to justify substitution request.

G. Substitution request, review and processing time shall in no way justify additional time or cost to the Contract. Allow time for Architect’s review of all substitution requests in construction schedule.

H. Denial of substitution requests shall in no way justify additional time or cost to the Contract.

I. Approved substitutions shall in no way relieve contractor from requirements and responsibilities of the Contract Documents.

J. Contractor assumes all costs associated with installing approved substitutions. Contractor is responsible for all professional fees, including Architect and Engineers, for time required for review and any redesign services associated with substitutions and for costs associated with re-approval by Government Authority.

1. Should a contractor-proposed substitution or alternative sequence or method of construction require revision of the Contract Drawings or Specifications, including revisions for the purposes of determining feasibility, scope or cost, or revisions for the purpose of obtaining review and approval by authorities having jurisdiction, revisions will be made by Architect or other consultant of Owner who is the responsible design professional, as approved in advance by Owner.

2. Services of Architect or other responsible design professional for document revisions, researching and reporting on proposed substitutions or alternative sequence and method of construction shall be paid by contractor.

3. Costs of services by Architect or other responsible design professional of the Owner shall be paid on a time and materials basis, based on current hourly fee schedules, with reproduction, long distance telephone, travel costs and shipping costs reimbursable at cost plus 15% mark-up for handling and billing.

4. Such fees shall be paid whether or not the proposed substitution or alternative sequence or method of construction is ultimately accepted by Owner and a Change Order is executed.

5. If necessary, fees will be paid for through deductive change order to Contract.

K. Substitutions on the basis of unavailability of a product must be accompanied by letter on manufacturer’s letterhead stating lack of availability, and that contractor could not have known of unavailability at the time of bid. Substitution requests based on unavailable product that do not include required letter or language will be denied and contractor shall be responsible for providing products of equal to or better than quality level indicated at no additional cost or time to Contract.

L. Substitutions will not be considered if they are indicated or implied on shop drawing, product data or sample submittals. All requests for substitution shall be by separate written request from contractor. Contractor shall utilize Substitution Request Form provided by Owner.

M. Substitutions will not be considered if acceptance will require substantial revision of the Contract Documents or will substantially change the intent of the design, in the opinion of the Architect. The intent of the design shall include functional performance and aesthetic qualities.

N. Substitutions will not be considered when they are indicated or implied on submittals. All proposed substitutions must be requested with separate written requests.

O. Substitutions will not be considered for materials and systems indicated as Owner’s standards as defined under State Contracting Code 3400. This includes means and methods of construction, fasteners, attachments, and all other ancillary or accessory items associated with or in support of Owner’s standard material and system.
P. The contractor’s submittal and Architect’s acceptance of Shop Drawings, Product Data or Samples that indicate construction not complying with the Contract Documents, does not constitute an acceptable or valid request for substitution, nor does it constitute approval.

Q. In the event materials are substituted and installed without proper authorization, contractor shall remove such materials and install those specified at his own expense.

R. Contractor shall determine all effects approved substitutions will have on other portions of work and so inform his subcontractors and employees of these effects.

S. Architect reserves the right to reject substitution requests for products and systems that fail to satisfy life safety requirements.

End of Section 01 60 00
SECTION 01 73 00 - Execution Requirements

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 21 00 “Allowances.”
2. Section 01 31 00 “Project Management and Coordination.”
3. Section 01 32 00 “Construction Progress Documentation.”
4. Section 01 32 33 “Photographic Documentation.”
5. Section 01 33 00 “Submittal Requirements.”
6. Section 01 40 00 “Quality Requirements.”
7. Section 01 60 00 “Product Requirements.”
8. Section 01 73 29 “Cutting and Patching.”
9. Section 01 77 00 “Closeout Procedures.”
10. Section 01 78 23 “Operation and Maintenance Data.”
11. Section 01 78 39 “Project Record Documents.”
12. Section 01 79 00 “Demonstration and Training.”

1.2 Documentation

A. Submit certificate signed by licensed land surveyor certifying that location and elevation of improvements comply with requirements.

B. Submit 2 (two) copies of a final property survey showing the project layout work performed and record survey data, including but not limited to finish floor elevations and building location, paving locations and elevations, and utility locations and elevations.

1. Survey and layout data shall be reviewed by contractor prior to submission for Owner’s filing. Contractor shall wet sign each submittal copy certifying that:

   a. Field measurements have been determined and verified.
   b. Field construction criteria have been verified.
   c. Conformance with Drawings and Specifications requirements is confirmed.

2. Indicate clearly on survey and layout data whether the dimensions and coordinates are in compliance with Contract requirements. Contractor shall note clearly and sign each submittal certifying that reported date “conforms” to contract requirements.

3. Identify all deviations from requirements of Drawings and Specifications.

1.3 Quality Assurance

A. Obtain the services of a licensed 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 required.

B. Provide installers and workers practicing the best methods known to each particular trade. Use adequate numbers of skilled, experienced workers who are adequately trained and completely familiar with the requirements and methods needed for completion of the work. Provide adequate number of supervisors.
and foremen for each piece of work. Foreman and supervisors shall be skilled and experienced in the particular work they are managing. Workers, installers, subcontractors, foreman and supervisors must be able to read and speak English and must be able to communicate fluently in English with other parties and individuals involved with the work.

C. Where required by warranty requirements provide approved fabricators and installers. Provide written evidence of such approval on manufacturer’s letterhead from manufacturer.

D. Comply with all Cal/OSHA required safety measures required for fulfillment of the Contract and work.

E. The utility locator contractor shall have on staff a California licensed civil engineer experienced in this type of work and experienced project managers and utility survey technicians.

PART 2 - Products

2.1 Equipment

A. The site utility location equipment and instrumentation shall include and not necessarily be limited to the following: Electromagnetic utility locator instruments, radio frequency transmitters, antenna receivers, pipeline and cable detectors, ground penetrating radar, and other such devices necessary to accurately identify and locate the various types and sizes of the underground site utilities existing on campus. The existing underground site utilities on campus include and are not necessarily limited to steel pipe, iron pipe, copper pipe, concrete carriers, transite pipe, PVC pipe/conduit, vitreous clay pipe and electrical and telecommunications duct banks both with and without concrete encasement.

PART 3 - Execution

3.1 Examination

A. The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the work. Before construction, investigate and verify the location and points of connection of utility services.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services and other necessary utilities.

2. Provide a graphic survey showing location and depth of existing utilities and points of connection prepared by a land surveyor licensed to practice in project location.

B. The existence and location of construction indicated as existing is not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the work.

C. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations with photos, video and notations.

1. If requirements of Contract Documents create conditions and conflicts, within the various elements of the work or between materials, or applications, which are detrimental to performance of the work provide an RFI to the Architect. Provide for most expensive option at no additional cost or time to Contract.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers, curing compounds and other finishes and coatings. Assure that moisture
content of substrate is within acceptable written recommended limits of manufacturer of material to be applied to substrate.

3. Examine and verify rough-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

4. Examine and verify suitability of walls, floors, roofs and other elements to accept application and installation of products and systems.

5. Verify that substrate conditions do not negate required warranties. Review substrate conditions with material manufacturers and obtain written statement on manufacturer’s letterhead that substrate conditions satisfy warranty requirements.

6. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the work indicates contractor’s acceptance of surfaces and conditions.

D. Investigate and document all existing uses, occupancies, and functions of neighboring properties within 1,000 feet of project site. Verify that products and systems are fully compatible with surrounding uses.

E. Survey Control and Reference Points: Contractor shall locate and protect survey control and reference points. Control datum for survey shall be as indicated on Civil Drawings.

1. Comply with the current requirements for the “Preservation of Survey Monumentation Compliance” of the “Business and Professions Code.” Prior to construction, monuments shall be referenced in the field and “Corner Records” shall be prepared for filing in the Office of the County Surveyor. These shall be performed prior to filing of the Notice of Completion of the work.

2. Comply with requirements of authorities having jurisdiction for survey monumentation preservation on capital improvement projects where monumentation points are present.

3. Contractor shall be responsible for preparing and submitting proper documentation to the Office of the County Surveyor in compliance with authorities having jurisdiction.

4. Project finalization, Notice of Completion and release of retainage shall be contingent upon obtaining documentation from contractor’s project surveyor or engineer that monuments have been set or restored and that Corner Records have been filed with and to the satisfaction of the County Surveyor.

5. All costs and actions necessary for compliance with current regulations shall be included in the Contract Sum and Contract Time.

3.2 Preparation

A. Prepare and furnish information 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 utility companies and authorities having jurisdiction. Obtain necessary approvals and permits for work in public right of way.

B. 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 Owner, in writing, not less than 5 days in advance of proposed utility interruptions. Indicate length in hours for scheduled interruption.

2. Do not proceed with utility interruptions without Owner’s written permission.

3. Schedule utility outages and shutdowns to nights, weekends, holidays or times and dates acceptable to Owner, as directed by Owner.

   a. Time and duration of outages and shutdowns shall not hinder Owner’s normal activities except as authorized in writing by Owner.
Execution Requirements
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C. Locate and lay out all vertical and horizontal controls of all site improvements, including pavement and edges, planting areas, fixture locations, tree locations, pavement scoring lines, retaining walls, water features, curbs, gutters, parking layouts, grading, fill and topsoil placement, utility slopes, and invert elevations, and all other site features indicated.

D. Locate and lay out all horizontal and vertical 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. Continuously maintain a log at project site of layout control work as work progresses. 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 review by Owner, Architect and Inspector.

3.4 Field Engineering

A. Locate 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. Report in writing lost or destroyed permanent benchmarks or control points promptly.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points. Maintain necessary stakes and pins throughout project.
   3. Contractor shall excavate all holes necessary for line and grade stakes.

B. Upon completion of rough grading, survey all graded areas and elevations along property lines to establish that elevations are correct and within acceptable tolerances for paving, construction and finish grading.

C. On completion of each element of work requiring field-engineering services, prepare and provide a certified survey showing dimensions, locations, angles, and elevations of construction and site work.

D. Establish a minimum of two permanent monuments on site, referenced to established control points. Record locations, with horizontal and vertical data, on project record drawings.

   1. In accordance with Professional Land Surveyor Act, Section 8772, any monument set by a licensed land surveyor or registered civil engineer to mark or reference appoint on a property or land line shall be permanently and visibly marked or tagged with the certificate number of the surveyor or civil engineer setting it, each number preceded by the letters “L.S.” or “R.C.E.” respectively, as the case may be, or, if the monument is set by a public agency, it shall be marked with the name of the agency and the political subdivision it serves.
   2. Nothing in this Section shall prevent the inclusion of other information on the tag which will assist in the tracing or location of survey records which relate to the tagged monument.
   3. Centerline ties filed with the County Surveyor will be checked for compliance with this law.

E. Prepare a final property survey showing significant features for project. Include on the survey a certification, signed by licensed surveyor, that principal metes, bounds, lines, and levels of project are accurately positioned as shown on the survey. 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.

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, conduit and wiring in finished areas, unless otherwise indicated.
   4. Maintain minimum headroom clearance required by building authority in spaces without a ceiling.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated. Install products in a manner that satisfies warranty requirements and is recommended in writing by manufacturer.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion. Prepare substrates and surfaces as recommended in writing by manufacturer. Perform work when existing and forecasted weather conditions are within limits recommended in writing by manufacturer. Comply with manufacturer’s written temperature and humidity requirements. Allow materials to adjust to ambient conditions as recommended by manufacturer in writing prior to installation.

D. Conduct construction operations so no part of the work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Do not use tools or equipment that produce harmful noise levels to building occupants.

F. Obtain and distribute templates to parties involved for factory prepared and field installed work. Check Shop Drawings and coordinate with other work to confirm that adequate provisions are made for locating and installing fabricated products.

G. Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the work.
   1. Where mounting heights are not indicated, submit an RFI to verify mounting heights.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to project site in time for installation.

H. Make joints of uniform width. Where joint locations in exposed work are not indicated, submit RFI to verify joint location. Measure, layout, plan, cut and fit exposed connections together to form hairline joints.

I. After sub-contractors and trades have completed portions of work, inspect work and adjacent areas and make any adjustments necessary.

J. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

K. Use products, cleaners, and installation materials that are not considered hazardous, and are fully compatible with installed products and finishes.

L. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
3.6 Progress Cleaning

A. Clean project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

2. Do not hold waste materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80° F.
3. Containerize unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations. Do not store unsanitary or unsafe waste inside building.
5. Do not store flammable, unsafe, unsanitary or odorous waste in a manner or location that would adversely affect pedestrians, building occupants, adjacent buildings and occupants, and properties.

B. Maintain project site free of loose, scattered waste materials and debris.

C. 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, vacuum the entire work area, as needed.

D. Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Remove debris from concealed spaces before enclosing the space.

F. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Burying or burning waste materials on-site is not permitted. Washing waste materials down sewers or into waterways is not be permitted.

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. Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

K. Clean sidewalks, driveways and streets frequently to maintain public thoroughfares free of dust, debris and other contaminants.

L. Keep parking areas clear of construction debris, especially debris hazardous to vehicle tires.

M. Keep site accessways, parking areas and building access and exit facilities clear of mud.
N. At a minimum, clean work areas daily.

3.7 Starting and Adjusting

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Coordinate schedule for start-up of various equipment and systems.

C. Notify Inspector and owner prior to start-up of each item.

D. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence or other conditions which may cause damage.

E. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

F. Verify wiring and support components for equipment are complete and tested.

G. Execute start-up under supervision of responsible manufacturer’s representative and/or contractor’s personnel in accordance with manufacturers’ instructions.

H. When specified in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, and check equipment or system installation prior to start-up and to supervise placing equipment or system operation.

I. Submit a written report to the Owner, Architect and Inspector that equipment or system has been properly installed and is functioning correctly.

J. Notify and assist Owner and Inspector for coordination of all utility hook-ups prior to hook-up.

K. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

L. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 Protection of Installed Construction

A. Provide final protection and maintain conditions that ensure installed work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.9 Correction of The Work

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Section 01 73 29 "Cutting and Patching." Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.
C. Remove and replace entire area of finish materials that are exposed to view if damaged surfaces cannot be repaired without visible evidence of repair.

D. Remove and replace damaged substrates and base structure if damaged by construction operations.

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 01 70 00
SECTION 01 73 29 - Cutting and Patching

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 40 00 “Quality Requirements.”
4. Section 01 60 00 “Product Requirements.”
5. Section 01 73 00 “Execution Requirements.”
6. Section 01 78 39 “Project Record Documents.”
7. Section 07 84 00 “Through-Penetration Firestop Systems.”

1.2 Quality Assurance

A. Provide a proposal describing procedures at least 10 (ten) days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Describe anticipated results. Include changes to structural elements and operating components as well as changes in building’s appearance and other significant visual elements.
3. List products to be used and firms or entities that will perform the work.
4. Indicate when cutting and patching will be performed.
5. List utility services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
6. Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work. Do not cut and patch structural elements without approval from Architect.

B. Do not cut, drill or notch structural elements unless detailed on structural drawings or without prior written authorization from the Structural Engineer.

C. 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 result in increased maintenance, decreased operational life or safety, or voids required or implied warranties. Such items include, but are not limited to:

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication systems.
6. Electrical wiring systems.
7. Water, moisture, or vapor barriers.
8. Membranes and flashings.
10. Equipment supports.
11. Piping, ductwork, vessels, and equipment.
12. Noise- and vibration-control elements and systems.

D. Do not cut and patch elements or related components in a manner that results in reducing their load carrying capacity, capacity to perform as intended, causes increased maintenance or decreased operational life or safety, or voids required or implied warranties.

E. Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces 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.

F. Sloppy, careless or avoidable cutting and patching will not be tolerated and work affected will be replaced at no cost or time to Contract. An aesthetically pleasing overall appearance of finished surfaces is a requirement of this project. Make necessary preparations, and use recommended techniques with great care to ensure that all finished surfaces are acceptable to Architect. Architect will be the sole judge of visual acceptability.

G. Before cutting and patching meet at project site with parties involved. Review areas of proposed cutting and patching, coordinate procedures and resolve conflicts before proceeding.

H. Contractor shall do all cutting, fitting, or patching of work as required to make its several parts come together properly and fit to receive or be received by work of other contractors shown upon, or reasonably implied by, the Drawings and Specifications for the completed structure as Architect may direct. In addition, the contractor shall do the following:

1. Uncover work to provide for installing, inspecting, or both, of ill-timed work.
2. Remove and replace work not conforming to requirements of the Contract Documents.
3. Remove and replace defective work.
4. Contractor to provide all necessary cutting and patching work outside project limit line to complete the project.

I. All cost caused by defective or ill-timed work shall be borne by contractor.

J. Contractor shall not endanger any work by cutting, excavating, or otherwise altering work and shall not cut or alter work of any other contractor except with consent of Architect.

K. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, notify the Architect and Owner and secure written permission.

L. Provide firms and workers with a minimum of 10 years experience in cutting and patching the types of substrates and systems on this project.

1.3 Warranty

A. Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials approved in writing by manufacturer’s of affected materials, so as not to void warranties. Architect will be the sole judge of visual acceptability.

PART 2 - Products
2.1 Materials

A. Comply with requirements specified in other Sections.

B. Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials. Architect will be sole judge of visual acceptability.

C. Provide necessary framing, blocking and support of openings cut into existing decks, walls, roofs and other substrates. Provide support in same depths as adjacent framing.

D. At Portland cement concrete paving, use concrete mixed with maximum 3/8-inch aggregate and a minimum 3000 psi 28-day compressive strength. Provide dowels to existing paving and reinforce new paving with minimum No. 3 reinforcing steel bars at 16-inches on center each way. Welded wire fabric reinforcement will not be acceptable.

E. Restore and compact areas trenched, disturbed or damaged. Provide sod or seeded planting mix, to match existing lawn or grass area.

F. Match existing products and finishes. Confirm colors, patterns and textures with Architect. Custom cut new materials to fit and to match joint patterns with existing materials.

G. Custom cut new ceramic tile and acoustical panel materials to size to match existing construction.

PART 3 - Execution

3.1 Examination

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed. After uncovering work, examine conditions affecting installation of new work.

1. Before cutting and patching, verify compatibility with and suitability of patching materials and substrates, including compatibility with in-place finishes and primers.

2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected. Proceeding with cutting and patching work constitutes acceptance of substrate and conditions by contractor.

3.2 Preparation

A. Provide temporary support of work to be cut.

B. 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.

C. Avoid interfering with use of adjoining areas or interrupting the free passage to adjoining areas.

D. Where existing utility services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

E. Locate all utilities prior to any cutting or excavation.

3.3 Performance
A. Employ adequate number of skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. 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. Cut new and existing in-place materials by sawing, drilling, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Cut or drill from the exposed or finished side into concealed surfaces.
3. Cut concrete and masonry using a cutting machine, such as an abrasive saw or a diamond-core drill for smooth edges. Do not over cut corners. Core drill holes through concrete and masonry. Pneumatic tools will not be allowed without prior approval.
4. For excavating and backfilling comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
5. 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.

C. Patch new and existing in-place materials by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Test and inspect patched areas after completion to demonstrate integrity of installation.
2. Restore substrates and exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Provide an even surface of uniform finish, color, texture, and appearance to match adjoining surfaces. Remove finishes and replace with new materials, if necessary as determined by Architect, to achieve uniform color and appearance.
4. Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Patch exterior components in a manner that restores enclosure to a weathertight condition.
6. Where patching occurs on a painted surface, apply primer and intermediate coats over patched area. Apply final coat over entire surface containing patch. Provide additional finish coats over entire surface until patch blends with adjacent surface, at no additional cost to Owner.
7. Restore substrates and finishes with products that comply with product Sections of the Specification.
8. Fit work neat and tight allowing for expansion and contraction.
9. Adjoin new finishes to in-place exposed structure, pipes, ducts, conduit, and other penetrations through surfaces, in a manner that is consistent with requirements of the Contract Documents.
10. For continuous surfaces, refinish to nearest intersection or natural break.
11. For an assembly, refinish entire unit.
12. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with material in accordance with Contract Documents to full thickness of the penetrated element.

D. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

End of Section 01 73 29
SECTION 01 74 19 - Construction Waste Management

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 11 00 “Summary.”
2. Section 01 21 00 “Allowances.”
3. Section 01 31 00 “Project Management and Coordination.”
4. Section 01 32 33 “Photographic Documentation.”
5. Section 01 50 00 “Temporary Facilities and Controls.”
6. Section 01 73 00 “Execution Requirements.”
7. Section 01 77 00 “Closeout Procedures.”
8. Section 02 41 19 “Selective Demolition.”

1.2 Definitions

A. Construction Waste: Materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

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 Performance

A. The Owner has established that this project shall generate the least amount of landfill waste possible and that processes that ensure the generation of as little landfill waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors shall be employed.

B. Of the inevitable waste that is generated, as many of the waste materials as economically feasible shall be reused, salvaged, or recycled. Waste disposal in landfills shall be minimized. Practices such as deconstruction, on-site crushing and reuse of concrete/asphalt as base material, salvage of fixtures, and recovering recyclable materials should be implemented.

C. Develop waste management plan that results in end-of-project rates for salvage/recycling of 50 percent by weight of total waste generated by the work.

D. Owner’s goal is to recycle as much nonhazardous demolition and construction waste as possible.
E. Field verify dimensions indicated on construction documents before confirming product orders or proceeding with work, to minimize waste due to excessive materials.

F. Contractor is responsible for full implementation of all programs involving tax credits or rebates or similar incentives related to recycling, if applicable to the project. Contractor is responsible for researching and obtaining information packets relevant to all such programs prior to starting work on the project. Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner.

1.4 Submittals

A. Submit 1 (one) PDF copy of waste management plan to Architect within 7 (seven) days of receipt of Notice to Proceed and prior to any waste removal from the site.

B. Concurrent with each Application for Payment, submit one (1) electronic copy of waste reduction progress report. Include the following information:
   1. Material categories.
   2. Total quantity of each waste item in tons, cubic feet or other appropriate unit of measure.
   3. Quantity of waste salvaged, both estimated and actual measured units.
   4. Quantity of waste recycled, both estimated and actual measured units.
   5. Total quantity of waste recovered (salvaged plus recycled).
   6. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
   7. Include manifests, weight tickets, receipts and invoices to justify amounts indicated.

C. Before request for Substantial Completion, submit three (3) copies of the following records:
   1. Calculated end-of-project rates for salvage, recycling, and disposal as a percentage of total waste generated by the work.
   2. Receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
   3. Receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
   4. Receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices to justify amounts indicated.
   5. Receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices to justify amounts indicated.
   6. Qualification Data for waste management coordinator and refrigerant recovery technician.
   7. 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.

1.5 Quality Assurance

A. Provide Refrigerant Recovery Technician certified by EPA-approved certification program.

B. Conduct Waste Management Conference at project site.

C. Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Comply with the California Integrated Waste Management Act of 1989 (AB 939).

E. Comply with the California Code of Regulations Title 14, Section 18700.
1.6 Waste Management Plan

A. Within 10 (ten) days of date of Notice to Proceed provide a waste management plan consisting of waste identification and waste reduction work plan. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan. Include separate sections in plan for demolition and construction waste, include cost/revenue analysis.

B. Indicate anticipated types and quantities of waste generated by the work. Include estimated quantities and assumptions for estimates.

C. List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill. Include points of waste generation, total quantity of each type of waste and means of recovery, handling and transportation procedures.

1. Provide analysis of the proposed jobsite waste to be generated, including types and quantities. Provide a list of each material proposed to be salvaged, reused, or recycled during the course of the project, the proposed local market for each material, and the estimated net cost savings or additional costs resulting from separating and recycling (versus landfilling) each material. “Net” means that the following have been subtracted from the cost of separating and recycling:

   a. Revenue from the sale of recycled or salvaged materials.
   b. Landfill tipping fees saved due to diversion of materials from the landfill.

2. For materials that will be salvaged and reused in this project, describe methods for collecting, preparing, transporting, and storing salvaged materials before incorporation into the work.

3. Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers. Indicate procedures required by recycling facilities to store, handle and transport materials for recycling.

4. Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and disposal facility, tipping fees and projected cost of disposing of all project waste in the landfill.

5. Include description of method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on project site where materials separation will be located.

D. Indicate total cost of waste disposal as if there was no waste management plan, and the net additional cost or net savings resulting from implementing waste management plan.

E. Include the following:

1. A description of the regular meetings to be held to address waste management. Refer to Section 01 31 00 “Project Management and Coordination.”

2. A description of the means by which any waste materials, identified for salvage and recycling, will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.

3. A description of the means of sorting and transportation of the recyclable materials and destination of materials.

1.7 Delivery, Storage and Handling

A. Coordinate the schedule of product deliveries in order to minimize site storage time and potential damage to stored materials and to minimize waste due to excessive materials handling and misapplication.
B. Set aside and protect misdelivered and substandard products and materials and return to supplier for credit.

C. Store products and materials in a manner to prevent damage and contamination.

PART 2 - Products (Not Used)

PART 3 - Execution

3.1 Plan Implementation

A. Implement waste management plan as approved by Architect and Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. 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. Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the work occurring at project site. Distribute waste management plan to everyone concerned within 3 (three) days of submittal return. Review plan and procedures with all trades and workers. Coordinate waste management, material handling and separation requirements with all trades.

D. Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities. Designate and label specific areas on project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

E. Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in order to prevent contamination of materials and to maximize recyclability and salvageability of identified materials.

3.2 Salvaging Demolition Items

A. Salvaged Items for Reuse in the Work:
   1. Clean salvaged items.
   2. Store and protect items in a secure area until installation.
   3. Protect items from damage during transport.
   4. 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.
   5. Keep items dry at all times.

B. Salvaged Items for Owner's Use:
   1. Clean salvaged items.
   2. Store and protect items in a secure area until delivery to Owner.
   3. Transport items to Owner's storage area designated by Owner.
   4. Protect items from damage during transport.
   5. Keep items dry at all times.

3.3 Recycling Waste
A. Arrange for timely pickups from the site and deliveries to recycling facility in order to prevent contamination of recyclable material. Designate specific areas for separation and storage of salvaged and recycle materials. Keep areas neat and clean, in an orderly manner, and well labeled. Contractor shall make arrangements with the waste hauler for providing source separated bins so that the contractor can keep recyclable materials separated to a level that a recycling facility can accept them. Contractor shall take materials to a Transformation Facility whenever feasible and cost effective. Each transformation will only accept limited waste streams. The contractor is responsible to determine if its specific waste stream is accepted by each facility.

B. Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at project site to the maximum extent practical.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from project site. Include list of acceptable and unacceptable materials at each container and bin.
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 off Owner’s property and transport to recycling receiver or processor.

C. Break up asphaltic concrete paving and transport paving to asphalt-recycling facility.

D. Remove reinforcement and other metals from concrete and sort with other metals. Break-up and transport concrete to recycling facility.

E. Remove metal reinforcement, anchors, and ties from masonry and sort with other metals. Clean and stack undamaged, whole masonry units on wood pallets. Transport masonry to recycling facility.

F. Sort and stack wood members according to size, type and length. Separate lumber, engineered wood products, panel products, and treated wood materials. Grind or chip lumber cut offs into small pieces. Bag sawdust that does not contain painted or treated wood and transport to recycling facility.

G. Separate metals by type:

1. Structural Steel: Stack members according to size, type of member and length.
2. Remove bolts, nuts, washers and other rough hardware.
3. Sort and pile metal reinforcing.
4. Sort and pile anchors, ties, clips and other miscellaneous metal items.

H. Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

I. Stack large clean gypsum board pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners. Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

J. Stack large clean acoustical ceiling panels and tiles on wood pallets and store in a dry location. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.

K. Roll large carpet pieces tightly after removing debris, trash, adhesive, and tack strips. Store clean, dry carpet in a closed container or trailer provided by carpet recycler.
L. Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

M. Separate plumbing fixtures by type and size.

N. Reduce piping and metallic conduit to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

O. Separate lamps by type and protect from breakage.

P. Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

Q. Sort plastic conduit and pipe by size and length.

R. Packaging:
1. Break down packaging and cardboard into flat sheets. Bundle and store in a dry location.
2. Separate and bag Polystyrene Packaging materials.
3. 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. Break down crates into component wood pieces and comply with requirements for recycling wood.
5. Collect beverage containers and paper waste used by onsite workers and sort by material.

S. Chip removed brush, branches, and trees on site. Recycle as mulch. Remove from site if necessary.

T. Provide Owner with material and weight certificates from recycling plant.

U. Credits for recycling of materials belong to Owner. Revenue generated from recycling goes to contractor.

3.4 Disposal of Waste

A. Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from project site and legally dispose in a landfill acceptable to authorities having jurisdiction.

1. Do not allow landfill waste materials that are to be disposed of to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces, site areas, and routes of transport.
3. Transport landfill waste materials off Owner’s property and legally dispose of them. Provide disposal certifications.

B. Do not burn waste materials.

End of Section 01 74 19
SECTION 01 77 00 - Closeout Procedures

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 29 00 “Payment Procedures.”
2. Section 01 31 00 “Project Management and Coordination.”
3. Section 01 32 00 “Construction Progress Documentation.”
4. Section 01 32 33 “Photographic Documentation.”
5. Section 01 33 00 “Submittal Procedures.”
6. Section 01 50 00 “Temporary Facilities and Controls.”
7. Section 01 73 00 “Execution Requirements.”
8. Section 01 74 19 “Construction Waste Management.”
9. Section 01 78 23 “Operation and Maintenance Data.”
10. Section 01 78 39 “Project Record Documents.”
11. Section 01 79 00 “Demonstration and Training.”

1.2 Closeout Meeting

A. Owner, Architect and contractor will attend a meeting at the project site to review Contract closeout procedures and to review items to be completed and corrected. This meeting shall be scheduled not earlier than 14 days prior to the date anticipated for Substantial Completion review.

1.3 Substantial Completion

A. When contractor determines that the work is complete in accordance with the Contract documents, contractor shall submit to Architect and Inspector of Record written certification that the Contract Documents have been reviewed, the work has been inspected by the contractor and by authorities having jurisdiction, and the facility is ready for Substantial Completion review. Before requesting review for determining date of Substantial Completion assure the following items are complete. In request for review list any items that are incomplete.

1. Prepare a list of items to be completed and corrected in a punch list format.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer’s name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
10. Terminate and remove temporary facilities from project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover for utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. After review, Architect shall prepare and distribute a typewritten, comprehensive list of items to be completed and corrected (punch list) to make the work ready for acceptance by the Owner.

1. The punch list shall include all items to be completed or corrected prior to the contractor’s application for final payment.
2. Architect will review completed punch list items to verify completion.

C. Architect will prepare the Certificate of Substantial Completion or will notify contractor of items that must be completed or corrected before certificate will be issued.

1. If additional site visits are required by the Architect, Architect’s consultants and other design professionals in addition to those visits described in items 1.3 A and 1.3 B above to review completion and correction of the work, the costs of additional visits shall be reimbursed to the Owner by the contractor by deductive change order.

1.4 Final Completion

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

1. Submit a final Application for Payment with releases.
2. Submit certified Substantial Completion punch list of items to be completed or corrected stating that each item has been completed or otherwise resolved.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
6. Submit signed inspection reports.

B. Submit a written request for final review for acceptance. On receipt of request, Architect will either proceed with final review or notify contractor of unfulfilled requirements.

C. After review and acceptance Owner will execute a Final Completion Certificate.

1. If additional site visits are required by the Architect, Architect’s consultants and other design professionals in addition to those visits described in item 1.4 B above to review completion and correction of the work, the costs of additional visits shall be reimbursed to the Owner by the contractor by deductive change order.

1.5 Warranties

A. Assemble and organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Prior to submission, verify that documents are in proper form and contain all required information and are properly signed.
2. Organize warranty and guarantee documents into an orderly sequence based on the Table of Contents of the Project Manual.
3. Include Table of Contents for binder, neatly typed, following order and section numbers and titles as used in the Project Manual.
4. When operating and maintenance data manuals are required for warranted construction, include additional copies of each required warranty and guarantee in each required manual. Coordinate with requirements specified in Section 01 78 23 “Operation and Maintenance Data.”
5. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
6. Provide heavy paper dividers with 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.
7. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," project name, name and address of contractor.
8. Submit fully executed copies of warranties, guarantees and bonds within ten days of date of Notice of Completion.

B. Provide 3 (three) copies of extended warranties at time of Substantial Completion.

1.6 Final Payment
A. After completion of all items listed for completion and correction, after submission of all documents and products and after final cleaning; submit final Application for Payment, identifying total adjusted Contract Sum, previous payments and sum remaining due. Payment will not be made until the following are accomplished:
   1. All project record documents have been transferred and accepted by Owner.
   2. All extra materials and maintenance stock have been transferred and received by Owner.
   3. All warranty documents and operation and maintenance data have been received and accepted by Owner.
   4. All liens have been released or bonded by contractor.
   5. Contractor’s surety has consented to final payment.

1.7 Post-Construction Inspection
A. In accepting final payment, contractor shall agree to perform a post-construction inspection with representatives of the Owner, and if authorized by Owner, the responsible design professionals, to review performance of the completed work and to determine what, if any, corrections shall be performed by contractor in compliance with the contractor’s warranty, as described in the Conditions of the Contract.

B. No later than 300 days after the date of Substantial Completion, after occupancy and use of the facility by the Owner, at days and times as directed by Owner.

C. Inspection Activities:
   1. Contractor shall inspect, test and adjust the work, noting defects and corrective actions to be taken.
   2. Contractor shall instruct Owner’s operating personnel in operational requirements needed to maintain correct appearance and function of the facility.

D. Contractor shall prepare and submit to Owner, a typewritten report to identify deficiencies and corrective actions taken. Post-construction inspection report shall note when corrective actions are unable to restore defects in the work to compliance with the requirements of the Drawings, Specifications and manufacturer’s criteria.
E. Corrections shall be governed by provisions of the Conditions of the Contract.

PART 2 - Products

2.1 Materials

A. 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.

B. Provide close out documents in appropriately sized 3-ring binder with transparent vinyl insert sleeve on both front cover and binding edge. Use multiple binders if necessary.

PART 3 - Execution

3.1 Final Cleaning

A. Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations. Turn over project in a “like new” condition.

B. 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 cleaning operations before requesting inspection for certification of Substantial Completion for entire project. Cleaning operations include but are not limited to the following:

   a. Clean project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances. Remove and dispose all mock-ups that are not incorporated into work.

   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits. Wash all paved areas.

   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

   d. Remove tools, construction equipment, machinery, and surplus material from project site.

   e. 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.

   f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

   g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

   h. Remove labels that are not permanent.

   i. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration. Do not paint over name plates, labels, and similar identification items on parts and equipment.

   j. Wipe surfaces of mechanical, electrical, elevator and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

   k. Replace parts subject to unusual operating conditions.

   l. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
Closeout Procedures
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m. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

n. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

o. Clean all horizontal surfaces, exposed and not exposed to view, including, but not limited to, light fixtures, ledges, plumbing fixtures, tops of door and window frames, tops of doors and interiors of cabinets and casework.

p. Clean building accessories, including toilet partitions, fire extinguisher cabinets, lockers and toilet accessories, all plumbing fixtures and all lighting fixture lenses and trim.

q. Clean and buff all metalwork, to be free of soiling and fingerprints. Mirror finished metalwork shall be buffed to high luster.

r. Thoroughly sweep and wet mop floors in enclosed spaces. At parking areas and ramps, sweep and hose off floor surface.

s. Thoroughly sweep and mop tile flooring. Comply with specific requirements in manufacturer’s tile and installation materials.

t. Thoroughly sweep all resilient flooring. Damp wash all resilient flooring. Comply with specific requirements in applicable resilient flooring Sections, and notes of the Drawings.

u. Clean and vacuum all carpeting. Clean as necessary to restore to like-new condition.

v. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from all visible interior and exterior surfaces.

w. Leave project clean and ready for occupancy.

C. Engage an experienced, licensed exterminator to make a final inspection and rid project of rodents, insects, and other pests. Submit certifications that project is pest free at time of completion.

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

E. Turn over all keys to Owner.

F. Turn over additional materials and products as required by Contract Documents.

G. On occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

End of Section 01 77 00
SECTION 01 78 23 - Operation and Maintenance Data

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 32 33 “Photographic Documentation.”
2. Section 01 60 00 “Product Requirements.”
3. Section 01 77 00 “Closeout Procedures.”
4. Section 01 78 39 “Project Record Documents.”
5. Section 01 79 00 “Demonstration and Training.”

1.2 Copies

A. Provide 1 (one) PDF draft copies of each Operation and Maintenance Manual in final form at least 15 (fifteen) days before Substantial Completion. Architect will return one copy with comments. Correct or modify each manual to comply with Architect’s comments. Submit 3 (three) copies of corrected manual to Owner prior to final acceptance of the work by Owner.

1.3 Quality Assurance

A. Preparation of data shall be done by persons:

1. Trained and experienced in maintenance and operation of the described products.
2. Familiar with requirements of this Section.
3. Skilled in technical writing to the extent required to communicate essential data.
4. Skilled as drafters competent to prepare required drawings.

1.4 Coordination

A. Where Operation and Maintenance documentation includes information on installations by more than one factory authorized service representative, assemble and coordinate information furnished by multiple representatives.

PART 2 - Products

2.1 Manuals

A. Prepare and format data in the form of an instruction manual. 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 a title page, table of contents, and manual contents. Provide a manual for each building.

B. Enclose title page in transparent plastic sleeve. 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, address, and telephone number of contractor.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. List each product included in manual in a Table of Contents, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual. If manual requires multiple binders provide master table of contents in each binder and clearly identify each binder with a sequential number.

D. Organize sets into manageable size. Arrange contents alphabetically by system, subsystem, and equipment. Assemble instructions for each subsystem, equipment, and component of one system into a single binder; do not break information on an item or system into multiple binders.

1. Provide heavy-duty, 3-ring, vinyl-covered, loose-leaf 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 on inside covers to hold folded oversize sheets. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets. Indicate total number of volumes. Provide a Master List of all manuals showing number and Title.

2. Provide heavy-paper dividers with tabs for each section. Use printed labels on 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. Provide transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.

4. Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, neatly 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. Key drawings for reference by labeling envelopes.

E. Within each tabbed division, include data as published by the product manufacturer. All data shall be neatly typewritten. Strike-through information on printed literature not applicable.

F. Supplement the manufacturer’s printed data with neatly typewritten text and professionally drafted diagrams as necessary to suit the particular installation for the project and to fully explain operation and maintenance procedures. Provide logical sequence of instructions for each procedure.

G. Provide drawings and photos as needed to supplement operation and maintenance data to illustrate configurations and relationships of component parts of equipment and systems, and to show control and flow diagrams, as applicable. Do not use Project Record Documents as maintenance drawings.

H. Provide additional data as specified in individual product Specification Sections.

2.2 Emergency Manuals

A. Organize manual into a separate section for type of emergency, emergency instructions, emergency procedures and emergency contact information.
B. 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. Equipment Failure
8. Chemical Release or Spill

C. 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.

D. Include stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

2.3 Operation Manuals

A. Provide operation data, equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements. Organize into a binder by system, subsystem and equipment.

B. Include the following:

1. Product name and model number.
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.

C. Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.

D. Describe the sequence of operation, and diagram controls as installed.

E. Diagram piping as installed, and identify color-coding where required for identification.

2.4 Product Maintenance Manual

A. Organize manual into a separate section for each product, applied materials, and finishes. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below. Include catalog numbers, size composition, color, texture and sheen designations. Provide information for re-ordering products, materials and finishes.
B. 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 and supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Include product data for waterproofing, roofing, moisture protection and weather-exposed products listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer's name.
   3. Color, pattern, and texture.
   5. Reordering information for specially manufactured products.

E. Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.

F. Include lists of materials and local sources of materials and related services.

G. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.5 Systems and Equipment Maintenance Manual

A. 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 warranty and bond information, as described below.

B. 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.

C. Provide manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance identification, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment.

D. Include test and inspection instructions, troubleshooting guide, disassembly instructions, adjusting instructions and demonstration and training DVD, if available, that detail essential maintenance procedures. Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

E. 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.

F. 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. Provide parts list, illustrations, assembly drawings and diagrams as necessary for service and maintenance. Include complete nomenclature and catalog numbers for consumable and replacement parts. Provide list
of spare parts, current prices, and recommended quantities to be maintained in stock by the Owner or operator.

G. Include copies of maintenance agreements with name and telephone number of service agent.

H. Provide contractor’s coordination drawings, with piping diagrams as installed. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Color code diagrams as necessary for clarity.

I. Include test and balancing reports, as applicable and as specified in individual product Specification Sections.

J. Provide electrical service characteristics of panelboard circuit directories, controls and communications.

K. Include diagrams of wiring as installed, with color coding as necessary for clarity.

L. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds, including procedures to follow and required notifications for warranty claims.

PART 3 - Execution

3.1 Manual Preparation

A. Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the work. If data includes more than one item in a tabular format, highlight each applicable item and identify using appropriate references from the Contract Documents. Identify data applicable to the work and delete references to information not applicable.

B. 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. Do not use Contract Documents or Record Documents as part of operation and maintenance manuals.

End of Section 01 78 23
SECTION 01 78 39 - Project Record Documents

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 32 00 “Construction Progress Documentation.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 33 00 “Submittal Procedures.”
4. Section 01 60 00 “Product Requirements.”
5. Section 01 77 00 “Closeout Procedures.”
6. Section 01 78 23 “Operation and Maintenance Data.”

1.2 Submittals

A. Submit 1 (one) set of corrected Record Drawings and 1 (one) set of marked-up Record Prints.

B. Submit 1 (one) PDF copy of each Record Drawing whether or not changes and additional information were recorded.

C. Submit 1 (one) PDF copy of Project's Specifications, including addenda and contract modifications.

D. Submit 1 (one) PDF copy of each Product Data submittal.

PART 2 - Products

2.1 Record Drawings

A. Maintain one set of black-line on white record prints of the Contract Drawings.

1. Mark Record Prints to show the actual installation where installation varies from that shown on the current Contract Documents. Designate a single individual for life of project to record information into Drawings and Specifications. Maintain that individual for life of project. Do not change record keeper without approval from Owner.

2. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

3. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations. Record information continuously as work progresses.

4. Accurately record information in an understandable drawing technique. Use straight edge, circle template, and other devices as necessary to make lines, and use neat block lettering to record notes.

5. Mark record sets with erasable, colored pencil. Use colors to distinguish between changes for different categories of the work at same location. Establish legend to clearly define colors. Colors used shall be clearly reproducible through electronic scanning process into color PDF format.

6. Note construction field change directive numbers, alternate numbers, change order numbers, and similar identification, where applicable.

7. Mark changes to the documents caused by RFI responses with RFI designation.
8. Mark new information that is important to Owner, but was not shown on Contract Drawings or Shop Drawings.
9. Legibly and to scale, mark a reproducible set of Contract Drawings to record actual construction, including:
   a. Measured depths of foundations and footings encountered, measured in relation to finish first floor datum.
   b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent ground improvements.
   c. Field changes of dimension and detail.
   d. Details not on original Contract Drawings: Application of copies of details produced and provided by Architect during construction will be accepted.

B. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location on every sheet of Record Set whether all Drawings contain record marks or not.
   1. Organize Record Drawings into manageable set. Include identification on cover sheets. Logically number added sheets to fit established numbering and sequence.
   2. Scan each Record Drawing whether it contains marks or not and create a color PDF of each drawing. Make three sets.
   3. Bind each set with durable paper cover sheets with chip board front and back binding strip and three Chicago bolts for each set.
   4. Provide the following identification on each Record Drawing:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of contractor.
      e. Name of individual who prepared record information.

2.2 Record Specifications

A. Mark Specifications to indicate the actual product or method of installation that varies from that indicated in Contract Documents, addenda, and contract modifications. Same individual marking Record Drawings shall mark Record Specifications.
   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, catalog numbers and other information necessary to provide a record of selections made.
   4. Note related change orders.
   5. Indicate product substitutions and alternates utilized.
   6. Use neat block lettering to mark information. Use red pencil to mark changes. Do not write over text or on backs of pages.
   7. Make 3 color copies of Record Specifications and bind with plastic covers using 3 Chicago bolts for each copy.

2.3 Record Submittal Data

A. Mark Submittal Data to indicate the actual product installation where installation varies substantially from that indicated in 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.

2.4 Miscellaneous Record Information

A. Assemble miscellaneous records required in connection with actual performance of the work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1. RFIs and RFI Log.
2. FCDs and FCD Log.
3. Change Orders.

PART 3 - EXECUTION

3.1 Recording and Maintenance

A. Maintain one copy of each Record Document during the construction period for. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of project.

B. Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, in a fire resistive location, protected from deterioration and loss. Provide access to Project Record Documents for Owner’s and Architect's reference during normal working hours.

End of Section 01 78 39
SECTION 01 79 00 - Demonstration and Training

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 60 00 “Product Requirements.”
4. Section 01 73 00 “Execution Requirements.”
5. Section 01 77 00 “Closeout Procedures.”
6. Section 01 78 23 “Operation and Maintenance Data.”
7. Section 01 78 39 “Project Record Documents.”

1.2 Instruction Information

A. Provide instructional program for demonstration and training, including 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.

B. Provide demonstration and training DVD’s within 7 (seven) days of end of each training module.

1.3 Quality Assurance

A. Provide firms and individuals 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. Provide factory-authorized service representatives, complying with requirements in Section 01 40 00 “Quality Requirements,” experienced in operation and maintenance procedures and training.

C. Conduct pre-training meeting at project site. Review methods and procedures related to demonstration and training. Coordinate and arrange demonstration and training times with Owner.

D. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Owner.

PART 2 - PRODUCTS

2.1 Instruction Program

A. Develop an instruction program for each system and equipment item.

B. Develop learning objectives and teaching outlines. Include a description of specific skills and knowledge that participant is expected to master. Include instruction for each system based on the following:
1. Operation.
2. Documentation.
3. Emergencies.
5. Use operations and maintenance manuals as instruction guide.
6. Adjustments.
7. Troubleshooting.
8. Maintenance.
9. Repairs.

C. Prepare and insert additional data in operation and maintenance manuals when need for such data becomes apparent during construction.

PART 3 - Execution

3.1 Instruction

A. Engage a qualified facilitator to prepare instruction program, 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.

C. Provide instruction at mutually agreed upon times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with Owner with at least 7 (seven) days' advance notice.

D. At conclusion of training session, assess and document each participant's mastery of information by use of a demonstration performance-based test.

E. Assemble, produce and provide all training materials, visual aids and tools.

3.2 Demonstration and Training

A. Demonstrate operation and maintenance of products to Owner’s personnel within 7 (seven) calendar days of Substantial Completion and prior to occupancy.

B. For equipment or systems requiring seasonal operation, perform demonstration for other seasons within 6 (six) months.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner’s personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance and shutdown of each item of equipment at agreed-upon times at equipment location.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

F. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.
G. Record demonstration and training. Record each training session separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training session, record each chart containing learning objective and lesson outline.

H. Provide high-quality video in DVD format.

I. Describe scenes on video by audio narration by microphone while video is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction and elevation or story of construction.

J. At conclusion of training, assess and document each participant’s mastery of module by use of a demonstration performance-based test.

K. Restore systems and equipment to condition existing before demonstration.

End of Section 01 79 00
SECTION 02 41 19 - Selective Demolition

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 01 31 00 “Project Management and Coordination.”
2. Section 01 32 33 “Photographic Documentation.”
3. Section 01 50 00 “Temporary Facilities and Controls.”
4. Section 01 73 29 “Cutting and Patching.”
5. Section 01 74 19 “Construction Waste Management.”

1.2 Definitions

A. Remove: Detach items from existing construction in their entirety as required for new construction and legally dispose of them off-site.

B. Salvage: Detach items from existing construction and deliver them to Owner.

C. Remove and Reinstall: Detach items from existing construction in their entirety as required for new construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and will remain functional.

E. Abandon: Existing items of construction that are to be disconnected, shutdown and left in place.

1.3 Quality Assurance

A. Provide the services of an experienced firm that has specialized in demolition work similar in material and extent to that indicated for this project.

B. Provide a Refrigerant Recovery Technician certified by an EPA-approved certification program.

C. Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction. Comply with all applicable storm water, erosion and air quality regulations.

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Conduct pre-demolition meeting at project site. Review methods and procedures related to selective demolition. Issue meeting minutes.

F. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.4 Project Conditions
A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical. Owner assumes no responsibility for condition of areas to be selectively demolished.

C. Compare existing conditions with Construction Documents before proceeding with selective demolition. Immediately provide written RFI to Architect for resolution of any conflicts found.

D. It is not expected that hazardous materials are present within the existing conditions.
   1. Known hazardous materials will be removed by Owner before start of the work under a separate contract.
   2. If hazardous materials are encountered or suspected, do not disturb; immediately notify Owner in writing. Owner will remove hazardous materials under a separate contract.

E. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations. Re-route utilities if necessary to maintain service, without disruption of service, at no additional cost or time to Contract. Maintain fire-protection facilities in service during selective demolition operations.

F. Verify depth and locations of existing utilities to remain prior to start of selective demolition.

G. Storage or sale of removed items or materials on-site will not be permitted.

1.5 Warranty

A. Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - Products

2.1 Repair Materials

A. Provide necessary framing, blocking and support of openings cut into existing decks, walls, roofs and other substrates. Provide support in same depths as adjacent framing.

B. Use repair materials identical to existing materials.
   1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   2. Use materials whose installed performances equal or surpass that of existing materials.

C. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - Execution

3.1 Examination

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
C. Inventory and record the condition of items to be removed and reinstalled and items to be salvaged.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written RFI to Architect immediately.

E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations. If such condition exists submit written RFI to Architect immediately.

F. Record existing conditions by use of measured drawings, preconstruction photographs and templates. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials, assembly, construction, connection and interface with other materials, as needed to make exact reproduction.

G. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

H. Proceeding with selective demolition work constitutes acceptance of substrate conditions by contractor.

3.2 Mechanical/Electrical Systems

A. Maintain systems and components indicated to remain and protect them against damage during selective demolition operations.

B. Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Arrange to shut off indicated utilities with utility companies.
   2. If systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary systems that bypass area of selective demolition and that maintain continuity of systems to other parts of building.
   3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 Preparation

A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

B. Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
   2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
   3. Protect existing site improvements, appurtenances, and landscaping to remain.

C. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.

D. Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished. Strengthen or add supports when required to adequately support surrounding work during progress of selective demolition.

E. Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

3.4 Selective Demolition

A. Demolish and remove existing construction only to the extent indicated and as required by new construction. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations. Maintain adequate ventilation when using cutting torches.
4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
5. Dispose of demolished items and materials promptly. Remove decayed, infested, corroding or otherwise dangerous unsuitable materials promptly.
6. Remove structural framing members and lower to ground by method suitable to avoid free fall and prevent ground impact and dust generation.

B. Removed and Salvaged Items:

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

C. Removed and Reinstalled Items:

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

D. Protect construction indicated to remain against damage and soiling during selective demolition.

3.5 Selective Demolition Procedures for Specific Materials

A. Demolish concrete in sections. Cleanly cut concrete full depth at junctures with construction to remain and at regular intervals, then remove concrete between saw cuts.

B. Demolish masonry in small sections. Cleanly cut masonry at junctures with construction to remain, and then remove masonry between saw cuts.

C. Saw-cut perimeter of slab on grade areas to be demolished, then break up and remove.

D. Remove resilient floor coverings according to recommendations in RFCI-WP and its Addendum. Remove residual adhesive and prepare substrate for new floor coverings by method recommended in writing by floor finish manufacturer.

E. Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

F. Remove air conditioning equipment without releasing refrigerants.

3.6 Disposal of Demolished Materials

A. Remove demolished materials from project site. Comply with requirements of Section 01 74 19 “Construction Waste Management.”

B. Do not burn demolished materials.

C. Do not discard or bury demolished materials.

3.7 Cleaning

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

End of Section 02 41 19
SECTION 05 12 00 - Structural Steel

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 09 22 16 “Non-Structural Metal Framing.”
3. Section 09 90 00 “Painting.”
4. Section 10 22 39 “Folding Panel Partitions.”

1.2 Definitions

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.3 Submittals

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

B. Shop Drawings: Show fabrication of structural-steel components indicating all shop and erection details, including profiles, sizes, spacings, and locations of structural members, connections, attachments, fasteners, loads and tolerances.

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.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.

1.4 Quality Assurance

A. Provide a qualified installer who has a minimum of 5 years of documented experience with handling and erection of structural steel similar in scope and detail, participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.

B. Provide a qualified fabricator who has a minimum of 10 years of documented experience in the handling and fabrication of structural steel and who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant.

C. Provide welders who have successfully qualified by tests as prescribed in AWS Standard Qualification Procedure, B3.0-41, to perform the type of welding required.

E. Qualify welding procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." Provide certification that welders to be employed in work have successfully passed AWS qualification tests. Certification and recertification is contractor's responsibility.

F. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges," including Section 10 and comply with additional requirements of this section.
4. ASTM A 6 “General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.”
5. California Building Code (CBC) with amendments.

G. Comply with AISC Code of Standard Practice for Steel Buildings and Bridges, except as follows:

1. Modify Paragraph 4.2.1 by deletion of the following sentence: “This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as part of his preparation of these shop drawings.”
2. Delete Paragraph 4.2.1 in its entirety.
3. Modify Paragraph 7.9.3 by deletion of the following sentence: “The contract documents specify the sequence and schedule of placement of such elements.”

1.5 Delivery, Storage, and Handling

A. Deliver materials to site at intervals to insure uninterrupted progress of work.

B. 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 erosion and deterioration. Deliver structural steel to project site in such quantities and at such times to ensure continuity of installation.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

C. Handle pre-painted finish pieces with padded slings or other methods such that they are not damaged. Provide padding as required to protect while rigging and aligning members’ frames. Weld tabs for handling and temporary bracing and safety cabling only at points concealed from view in the completed structure.

D. Cranes shall not be allowed on building slab areas.

1.6 Coordination

A. Furnish 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.
PART 2 - Products

2.1 Structural-Steel Materials

A. W-Shapes and WT-Shapes: ASTM A 572, Grade 50 or ASTM A 992.

B. Channels, Angles, Shapes: ASTM A 36 typically, unless noted otherwise.

C. Plate and Bar: ASTM A 36 typically, unless noted otherwise.

D. Welding Electrodes: Comply with AWS D1.1, type as required for materials being welded. Provide E70 XX – low hydrogen electrodes for shielded metal arc welding. Provide E71 TXX wire type for flux-cored arc welding. Provide gas shield comprised of 75% Argon and 25% Carbon Dioxide ratio.

2.2 Bolts, Connectors, and Anchors

A. Bolts, Nuts and Washers: ASTM A 307 bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

2.3 Primer

A. Coordinate all primers for exposed structural steel with finish coatings indicated in Section 09 90 00 “Painting.”

B. Provide SSPC-Paint 25, Type I zinc oxide, primer for all non-galvanized steel in non-exposed conditions.

2.4 Grout

A. Provide exterior grade, nonmetallic, shrinkage-resistant grout per ASTM C 1107. Provide factory-packaged, noncorrosive, nonstaining grout, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 Fabrication


1. Provide camber in structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
5. Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates. Smooth and ease edges of holes.
6. Weld threaded nuts to framing and other specialty items as indicated to receive work specified in other Sections. Grind welds flush with surfaces so attached items sit tight to steel member.
7. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
8. Make welded connections by shielded-art method in accordance with AWS D1.1.
a. Welding shall be done in the shop unless otherwise shown or specified.
b. Prior to welding, preheat members in accordance with AISC Section J2.7.
c. All welds not otherwise identified shall be continuous fillet welds, with size based on AISC standards for thicker part being joined.
d. Welding gas shall be 75%-80% Argon, 20%-25% Carbon Dioxide; welding with pure Carbon Dioxide is not allowed.

9. Furnish column bases shop-attached to columns.
10. All shop welding shall be continuously inspected by certified inspector, except welding performed in shop of fabricator approved by the Division of the State Architect (DSA).

B. Perform thermal cutting by machine to greatest extent possible. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Accurately finish ends of columns and other members transmitting bearing loads.

E. Prepare shear connector steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

F. Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

G. Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning. Smooth and ease edges of holes.
   2. Cut, drill, or punch base-plate holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 Shop Connections

A. Provide connections indicated on Drawings.

B. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

2.7 Shop Priming

A. Clean surfaces to be primed. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 6, "Commercial Blast Cleaning."

B. Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats of shop primer to inaccessible surfaces after
assembly or erection. Change color of second coat to distinguish it from first. Shop prime all 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. Surfaces to receive sprayed fire-resistive materials.
5. Surfaces to receive galvanized coating.
7. Surfaces to receive specialized coating systems other than conventional prime and paint.

2.8 Source Quality Control

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in work that test reports and inspections indicate does not comply with the Contract Documents.

C. Testing agencies will determine mechanical properties of materials in conformance with ASTM A 370 of the following materials:

1. Structural steel shapes and tubing.
2. Anchor bolts.
3. Filler metals for welding.

D. In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency’s option:

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - Execution

3.1 Examination

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of conditions by contractor.

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.

B. Establish permanent benchmarks necessary for accurate erection of structural steel.

3.3 Erection

A. Assemble and set structural steel accurately in locations and to lines and elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and “Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.”

B. Establish permanent benchmarks necessary for accurate erection of structural steel.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges.”

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection or for correcting fabrication errors.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

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

I. Weld profile, quality, and finish shall be consistent with mockups approved prior to fabrication.

J. Field weld components as indicated on drawings. Do not field cut or alter structural members without approval of Architect. Welding gas shall be 20%-25% Carbon Dioxide and 75%-80% Argon. Welding with pure Carbon Dioxide is not allowed.

K. Obtain permission for any torch cutting or field fabrication from the Architect. Finish sections thermal cut during erection to a surface appearance consistent with the mockup.

L. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.

3.4 Field Connections

A. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp, and without exceeding tolerances of AISC’s ”Code of Standard Practice for Steel Buildings and Bridges” for mill material.
4. Full penetration welds between beams and columns shall be made with a small diameter wire electrode. For shielded metal arc welding (SMAW), the maximum permitted electrode diameter shall be 5/32 inch. For flux cored arc welding (FCAW), the maximum permitted electrode diameter shall be 5/64 inch. Stringer beads should not exceed 1/2 inch maximum. Weave beads are not allowed.
5. “Weld dams” are not allowed.
6. After welding, the backing bars and weld tabs are to be removed by air-arc backgouging. The weld root shall be inspected and tested for imperfections which, if found, are to be removed by air-arc backgouging to sound material. The backgouged area is to be welded and shall be reinforced with a fillet weld (weld type tc-u4b). The size of the reinforcing fillet weld shall be equal to the beam flange thickness, but not less than 1/4 inch or more than 3/8 inch.
7. Prior to welding, the entire joint shall be preheated to a minimum of 225° F or AWS D1.1 requirements, whichever is greater. Preheat temperature shall be measured at a distance of 3 inches in all directions away from the joint and shall extend through the column flange thickness over that same area. Preheat shall be verified by the welding inspector before welding proceeds. Immediately after welding, apply fire blankets over heated area to maintain a slow cooling process.
8. Electrodes shall be rated for a CVN toughness of 20 ft-lbs at negative 20° F and 40 ft-lbs at 70° F.
9. Welding shall be performed in accordance with a welding procedure specification (WPS) as required in AWS D1.1 and approved by the engineer of record. The WPS variables shall be within the parameters established by the filler-metal manufacturer.

3.5 Field Quality Control

A. Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections, and to perform tests as described in Section 01 40 00 “Quality Requirements.”

B. Field welds will be tested and inspected according to Section 1701A.5, Item 5, Chapter 17 and Section 2231A.5, Chapter 22A, Title 24, CCR.

C. Correct deficiencies in work that test reports and inspections indicate does not comply with the Contract Documents. Perform additional tests, at contractor’s expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

3.6 Repairs and Protection

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

B. After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural steel elements.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
END OF SECTION 05 12 00
SECTION 05 40 00 - Cold-Formed Metal Framing

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 12 00 “Structural Steel.”
2. Section 08 11 13 “Steel Doors and Frames.”
3. Section 09 22 16 “Non-Structural Metal Framing.”
4. Section 09 29 00 “Gypsum Board.”
5. Section 09 53 23 “Suspended Ceilings.”
7. Section 10 28 16 “Toilet and Bath Accessories.”

1.2 Performance Requirements

A. ASTM A 653, steel sheet, zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) by the hot-dip process.

B. ASTM A 1003, Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

C. AISI, North American Specification for the Design of Cold Formed Steel Structural Members.

D. AWS D1.3, Structural Welding Code, Sheet Steel.


F. ASTM C 645, nonstructural steel framing members.

G. ASTM C 954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inches to 0.112 inches in thickness.

H. ASTM C 955, Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks) and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.


J. ASTM A 90, weight (mass) of coatings on iron and steel articles with zinc or zinc-alloy coatings.

K. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120°F.
L. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure.

M. All cold-formed structural metal framing shall be designed in accordance with American Iron and Steel Institute (AISI) North American Specification for the Design of Cold Formed Steel Structural Members.

N. Design the wall system to avoid introducing load eccentricities from connections to the structural steel framing. Where the wall system connections introduce load eccentricities that are unacceptable to the Engineer of Record, provide bracing to the satisfaction of the Engineer of Record. The cost of such bracing shall be the contractor’s responsibility.

1.3 Submittals

A. Product Data: For each type of cold-formed metal framing product and accessory indicated. Submit manufacturer’s specifications, descriptive literature and load tables. Submit manufacturer’s erection instructions.

B. Shop Drawings: Provide shop drawings prepared by cold-formed metal framing manufacturer. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional Structural Engineer, registered in the state of the project, responsible for their preparation.

1.4 Quality Assurance

A. Take engineering responsibility for preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Provide 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 required. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those required for this project in material, design, and extent. Provide all services required to submit and satisfy the local governing agencies for plan check procedures and receiving all permits and approvals required for this portion of the work.


D. Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction. Products used in the assembly shall carry a classification label from a testing laboratory acceptable to authority having jurisdiction.

1. Construct fire-resistance-rated partitions in compliance with tested assembly requirements indicated in drawings.
2. Rated assemblies to be substantiated, from applicable testing using the proposed products, by contractor.
3. Both metal framing and wallboard manufacturers must submit written confirmation that they accept the other manufacturer’s products as a suitable component in the assembly. Acceptance is as follows:
a. If installation of both products is proper, no adverse effect will result in the performance of one manufacturer’s product by the other’s products.

b. Combining products can be substantiated by required assembly tests.

E. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

F. Conduct pre-installation meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."

G. Engage an experienced fabricator/installer who has at least 5 years cold-formed metal framing experience similar in material, design, and extent to that indicated. Installer to provide workers and supervision that is experienced in the installation of cold-formed metal framing.

H. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

I. Coordinate and participate in fabrication of mockups required by other sections of work.

1.5 Delivery, Storage, and Handling

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling in accordance with AISI’s “Code of Standard Practice.”

B. Store cold-formed metal framing off ground in a dry location, protect with a waterproof covering, and ventilate to avoid condensation in accordance with AISI’s “Code of Standard Practice.”

1.6 Coordination

A. Verify and coordinate work of trades before and during framing to assure adequate wall framing and backing is installed for all wall and ceiling attached such as but not limited to:

1. Grab bars.
2. Toilet room accessories.
3. Plumbing fixtures.
4. Cabinets and shelving.
5. Chalkboards and marker-boards.
6. Other similar architectural features and accessories.
7. Projection screens.
8. Light fixtures.
10. Signage.
11. Wall mounted door bumpers and stops.
12. Corner guards.
13. Wall bumper rails.
15. Wall-mounted hangers for plumbing mechanical and electrical equipment and brackets.

B. Coordinate with other Sections to determine mockup requirements requiring framing.
C. Coordinate with other Sections to determine blocking and backing requirements.

D. Coordinate erection of studs/joists with installation of service utilities to minimize discontinuity in framing. Align stud web openings.

E. Provide framed openings for all recessed components. Coordinate erection of framing with installation of service utilities to minimize discontinuity in framing. Align stud web openings.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide cold-formed metal framing by one of, or equal to, the following:

1. CEMCO.
2. Clark Western Building Systems
3. Consolidated Fabrication Corporation.
4. Dietrich Metal Framing; a Worthington Industries Company.
5. United Metal Products, Inc.

2.2 Materials

A. Studs, see stud schedule: Types, sizes and gages as indicated on Drawings.

B. Studs, 16 Gage and Heavier: ASTM A 653-08 SS Grade 50, Class 1, types, sizes and gages as indicated on Drawings, punched web unless otherwise indicated, with screw-type flanges.

C. Backing, 16 gage minimum unless otherwise indicated: ASTM A 653-08 Grade 50, Class 1, types, sizes and gages as indicated on Drawings, unpunched web with screw-type flanges.

D. Joists: ASTM A 653-08 SS Grade 50, Class 1, types, sizes and gages as indicated on Drawings, punched web unless otherwise indicated, configured to permit nesting.

E. Top Track:

1. Dietrich Metal Framing SLP-TRK by Brady Construction Innovations, Inc., ICC Report No. ESR-1042, or approved equal, same gage and material as wall framing or 16 gage, whichever is more restrictive, slotted leg width to suit stud width.
2. Slotted Track CST by CEMCO, ICC Report No. ESR-1042, or approved equal, same gage and material as wall framing or 16 gage, whichever is more restrictive.

F. Bottom Track: Same gage and material as wall framing or 20 gage, whichever is more restrictive, 1 inch leg unless noted otherwise, width to suit stud width.

G. Sills and Headers: Unpunched channels sized for stud flanges, gage the same as studs unless otherwise noted. Provide extended leg tracks at ceiling tracks under structural framing members and at sill tracks where flooring underlayment will be placed (poured) after wall framing.

H. Connector Devices: As indicated on Drawings.

I. Bridging: 20 gage, unless noted otherwise. Subject to requirements, provide:

1. Dietrich Metal Framing; Spazzer® 5400 Bridging and Bracing Bar (SPZS) or approved equal.
2. Dietrich Metal Framing; EasyClip™ U-Series™ Clip Angle or approved equal.

2.3 Framing Accessories

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   8. Stud kickers, knee braces, and girts.
   9. Joist hangers and end closures.

C. Provide specified, indicated and necessary clips, plates, bent plates, angles, channels, and similar components to secure materials, equipment and items of work specified in other Sections. This Section is not intended to specify each and every item of cold-formed structural metal framing required to complete the work. Coordinate with various trades and Sections of work for specific requirements.

2.4 Anchors, Clips, and Fasteners

A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.


F. Welding Electrodes: Comply with AWS standards.

2.5 Miscellaneous Materials

A. Galvanizing Repair Paint: SSPC-Paint 20.

B. Provide premixed, nonmetallic, noncorrosive, nonstaining exterior grade grout containing selected silica sands, Portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
C. Provide load bearing, high-density multimonomer plastic, nonleaching shims.

D. Provide closed-cell neoprene foam, 1/4 inch thick sealing gaskets in widths to match width of bottom track or rim track members.

2.6 Fabrication

A. Cold-formed metal framing may be shop or field fabricated. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing; do not shear torch cut.
3. Fasten cold-formed metal framing members by welding, bolting, or screw fastening. Wire tying, riveting or clinch fastening of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate screws and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet. Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch. Space individual framing members as indicated and no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheeting or other finish materials.

PART 3 - Execution

3.1 Examination

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of conditions by contractor.

3.2 Preparation

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
C. Grout bearing surfaces to ensure full contact between the underside of bottom track or rim track and the top of foundation wall or slab to ensure a uniform and level bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 General Installation

A. Conform to ASTM C 955 for bracing and bridging for screw application of gypsum board, gypsum sheathing and plaster lath.

B. Place and align tracks and install framing to configurations and spacings shown on Drawings.

C. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

D. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

E. Securely anchor cold-formed framing to supporting structure. Screw, bolt, or weld wall framing at horizontal and vertical junctures to produce flush, even, true-to-line joints with minimum variation in plane and true position not exceeding 1/16 inch.

F. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened. Coordinate framing with adjoining work.

1. Cut framing members by sawing; do not shear torch cut.
2. Fasten cold-formed metal framing members by welding, bolting, or screw fastening. Wire tying, clinch fastening, or riveting of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate screws and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
3. Drill holes; do not punch or use cutting torch.
4. Cut framing components squarely for attachment to perpendicular members or, as required, for an angular fit against abutting members.

G. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

H. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

I. Install insulation in framed walls and give particular consideration to framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work and areas that will receive pre-boarding prior to being concealed.

J. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
K. Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

L. Install framing members in one-piece lengths. Splice connections for tracks may be used only if indicated.

M. Install temporary bracing and supports to secure and support framing. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

N. Install insulation in framing work that will be inaccessible on completion of framing work and areas that will receive pre-boarding prior to being concealed. Give particular consideration to framing members, such as headers, sills, boxed joists, and multiple studs at openings.

O. Control joints for expansion and contraction in the walls shall be constructed with double studs separated as indicated on drawings. Control joint spacing shall not exceed 30-feet. Ceiling-height door frames may be used as vertical control joints. Door frames of less than ceiling height may be used as control joints only if standard control joints extend to ceiling from both corners of top of door frame. Control joints between studs shall be filled with firesafing insulation in fire rated partitions.

P. Install all supplementary framing, blocking, and backing required to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

3.4 Load-Bearing Wall Installation

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends. Space anchors as indicated.

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads. Align studs with bearing flutes of metal deck.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

G. Isolate steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. For curtain wall infill conditions, install deflection track, slide clips, or other means to accommodate vertical deflection and anchor to building structure.

2. Where studs bypass structure, connect studs with vertical slide clips to continuous angles or supplementary framing anchored to building structure.

3. Provide slip track where studs connect to overhead structure.
4. Provide fire rated slip track for fire rated assemblies where studs connect to overhead structure.

H. Install headers over wall openings. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads. Provide 1 inch long by 1/8 inch weld at 16 inches on center on both sides of framing members.
2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs by welding, and space jack studs same as full-height wall studs.
3. In addition to corner framing provide studs not more than 2 inches from each corner of wall or abutting construction.

I. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

J. Install horizontal bridging in wall studs, spaced in rows not more than 48-inches apart. Fasten at each stud intersection.

1. Install additional row of horizontal bridging in wall stud beneath deflection track when wall studs are not fastened to an additional top track.
2. Cut bridging to fit between, and welded to, studs or inserted through cutouts in the web of each stud and secured to studs with welded clip angles. Provide bridging as indicated on Drawings.

K. Install steel diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

L. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 Sound Insulated Walls and Partitions

A. Embed floor runner tracks in two beads of acoustical sealant or two strips of compressed tape seal. Install the top track in same manner for full-height insulated walls. Where wall ends abut concrete, masonry, or steel, set end studs in two beads of acoustical sealant or two tape seals and secure at 4-foot centers vertically. At irregularities in surfaces, provide additional layers of sealant or tape as required to obtain compression.

3.6 Backing Plates and Anchorage

A. Install plates of lengths to span over at least three stud supports, equipped with two countersunk machine screws at each support except plates may be welded to supports 16 gage or heavier. Wall-mounted items requiring backing plates include but are not limited to items in this Section.

3.7 Field Quality Control

A. Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to continuous inspection and subsequent testing.

C. Testing agency will report test results promptly and in writing to contractor and Architect.
D. Remove and replace work where test results indicate that it does not comply with specified requirements.

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

3.8 Repairs and Protection

A. Prepare and repair damaged galvanized coatings on installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00
SECTION 06 40 00 - Interior Architectural Woodwork

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 08 11 13 “Steel Doors and Frames.”
3. Section 09 22 16 “Non-Structural Metal Framing.”
4. Section 09 29 00 “Gypsum Board.”
5. Section 09 30 00 “Tile.”
6. Section 09 53 23 “Suspended Ceilings.”
7. Section 09 65 00 “Resilient Flooring.”
8. Section 09 68 00 “Carpet.”
9. Section 09 90 00 “Painting.”
10. Section 10 11 00 “Visual Display Surfaces.”
11. Section 10 22 39 “Folding Panel Partitions.”
12. Section 12 35 50 “Institutional Casework.”
13. Division 22 Plumbing Sections.
14. Division 26 Electrical Sections.
15. Division 27 Communications Sections.

1.2 References

A. Builders Hardware Manufacturers Association (BHMA):

1. BHMA A156.9 “American National Standard for Cabinet Hardware.”
2. BHMA A156.18 “American National Standard for Materials and Finishes.”


C. Hardwood Plywood Manufacturer’s Association (HPMA), “HP – American Standard for Hardwood and Decorative Plywood.”


E. U.S. Department of Commerce, Product Standard (PS):

1. PS 1 “Construction and Industrial Plywood.”
2. PS 20 “American Softwood Lumber Standard.”

1.3 Submittals

A. Product Data: For each type of product indicated, including cabinet hardware and accessories, and finishing materials and processes. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when
tested according to ASTM D 5516 and ASTM D 5664. Include current research/evaluation report for fire-retardant-treated lumber and plywood, as acceptable to Division of the State Architect (DSA).

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show details full size.
   2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   3. Show locations and sizes of cutouts and holes for plumbing fixtures, piping, conduit, and accessories installed in architectural woodwork.
   4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
   5. Apply WI-certified compliance label to first page of shop drawings. Comply with Woodwork Institute requirements for shop drawing preparation.
   6. Show casework and counter layout on scaled room plans. 1/8 inch minimum.

C. Samples for Verification:
   1. Lumber with transparent finish, not less than 5 inches wide by 10 inches long, for each species and cut, finished on 1 side, 1 edge and 1 end.
   2. Veneer-faced panel products with transparent finish, 8 by 10 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
   3. Lumber and panel products with shop-applied opaque finish, 5 by 10 inches for lumber and 8 by 10 inches for panels, for each finish system and color, with half of exposed surface finished.
   4. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish applied to core material and specified edge material applied to 1 edge.
   5. Solid-surfacing materials, 6 inches square.
   6. Corner pieces as follows:
      a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
      b. Miter joints for standing trim.
   7. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.4 Quality Assurance

A. All wood products shall originate in “certified well-managed” forests as determined by standards endorsed by the Forest Stewardship Council. Timber products shall come from sources adopting environmentally friendly practices in forest management, logging and processing. Acceptable practices shall mean forests that are being managed through professionally administered forestry management and logging plans that assure regeneration of desired species following harvest. Forest management shall also include protecting rivers and streams from degradation, minimizing damage to the forest when harvesting, protecting biodiversity, operating in concert with the lawful interests of local populations, and maximizing both the yield and value of the forest products. Provide certification of conformance with environmental protection requirements specified above. Certificates shall indicate chain of custody from country and forest of origination through manufacturing and fabrication.

B. Provide fabricator that employs skilled workers who custom-fabricate products similar to those required for this project and whose products have a 10 year minimum record of successful in-service performance. Shop is a licensee of WI’s Certified Compliance Program.

C. Installer Qualifications: Fabricator of products.
D. Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and wood doors with face veneers that are sequence matched with woodwork and transparent-finished wood doors that are required to be of same species as woodwork.

E. Comply with WI's "Manual of Millwork" for indicated architectural woodwork. Provide WI-certified compliance certificates indicating that interior architectural woodwork and casework, including installation and finishing, meets or exceeds requirements of grades specified.

F. Casework construction and installation details shall comply with applicable seismic criteria of California Building Code (CBC). Operable parts for all accessible casework shall comply with CBC Section 11B-309.

G. Issue WIC Certified Compliance Certificate after fabrication and prior to shipping casework to work site.
   1. Each unit of casework shall bear the WIC Certified Compliance label.
   2. Each countertop shall bear the WIC Certified Compliance label.

H. Comply with CBC for flammability and smoke regulations.

I. Countertops construction and installation shall comply with solid polymer manufacturer’s details except as indicated on Drawings. Should neither manufacturer’s details nor details indicated on Drawings describe condition, construct and install solid polymer fabrication in accordance with appropriate typical details in WIC “Manual of Millwork.”

J. Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

K. Conform to CBC requirements for member and fastener sizes and type of fasteners, unless otherwise indicated on Drawings.

L. Before beginning actual work, install mockups of at least 8’ x 8’ in surface area to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for each type of architectural woodwork finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
      a. Inside and outside corners.
      b. Window Openings.
      c. Door openings.
      d. Flashings and underlayments.
      e. Transitions to other finish materials.
      f. Screeds, joints, casings and other accessories.
      g. Sealant joints.
      h. Sheathing, framing and substrates.
      i. Transparent finishes.
      j. Trim and paneling.
      k. Attachments.
      l. Upper and lower casework.
      m. Tall casework.
      n. Countertops and splashes.
      o. All end conditions.
      p. Countertop seam locations.
2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

M. Conduct pre-fabrication meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make necessary adjustments in fabrication strategy to meet requirements without additional cost or time to Contract.

N. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.5 Delivery, Storage, and Handling

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

B. Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at intended occupancy levels during the remainder of the construction period. Condition woodwork for a minimum of 5 calendar days, at intended environmental occupancy levels before installation.

C. Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements and indicate measurements on shop drawings. Where field measurements cannot be made due to progress of work, coordinate with appropriate trades to determine dimensions and proceed with shop drawings. Coordinate with trades to assure required dimensions are provided. Allow for field adjustments.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before framing is enclosed, and indicate measurements on shop drawings.

D. Deliver products with binding and protective coverings intact. Use bindings which do not mar or deform products.

E. Store products in clean, dry locations, stacked to ensure proper ventilation. Protect against dampness and extremes of humidity and temperature, before and after delivery. Minimum temperature (interior products) shall be 60°F. Maximum relative humidity shall be 55 percent.

F. Prevent soiling, marring and moisture damage.
G. Obtain and comply with manufacturer’s recommendations for optimum temperature and humidity conditions for solid surfacing material during its storage and installation.

1.6 Coordination

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections prior to enclosing framing, to ensure that interior architectural woodwork can be supported and installed as indicated. All applied products require fastening to solid wood blocking and backing. Toggle bolts or other hollow wall fasteners will not be permitted except where specifically noted.

B. Coordinate rough-in for items installed through or in millwork and trim. Locate rough-ins for proper alignment with edges, faces and reveals.

C. Where architectural woodwork is intended to match species, finish and color of wood doors. Coordinate with woodwork fabricator and door supplier to assure matching appearance.

1.7 Project Conditions

A. Do not install casework, woodwork and trim until required temperature and relative humidity conditions have been stabilized and will be maintained in installation areas.

B. Condition interior finish carpentry products to building environment. Maintain temperature and humidity at completed work as identical to conditions in occupied building.

C. Field verify dimensions for shop fabricated items before production.

1.8 Sequencing and Scheduling

A. Install finish carpentry only after building is made weathertight and after high humidity producing activities are completed.

B. Schedule applications of finishes and protective coatings to minimize exposure of unprotected surfaces to weathering.

1.9 Warranty

A. Provide manufacturer’s warranty against defects in materials, fabrication and installation, excluding damages caused by physical or chemical abuse or excessive heat. Warranty shall provide for replacement or repair of material and labor for a period of 2 years. For fabrications with installed warranty coverage, affix manufacturer’s fabrication/installation source plate.

PART 2 - Products

2.1 Materials

A. Provide materials that comply with requirements of WI’s quality standard for each type of woodwork and quality grade specified.

B. Wood Species and Cut for Opaque Finish: Plain Sliced White Birch:

C. Wood Products: Comply with the following:

1. Softwood Plywood: DOC PS 1, Medium Density Overlay.

D. Provide softwood products at time of delivery, as follows:

1. Interior finish lumber, trim and millwork (1-1/4-inch or less nominal thickness): 12 percent in 85 percent of pieces and 15 percent in remainder.
2. Exterior treated and untreated finish lumber and trim (4-inches or less nominal thickness): 15 percent.
3. Other wood products: In accordance with reference standards under which products are produced.
4. Moisture content of hardwood products at time of delivery: Lumber, trim and millwork shall be 6 percent.

E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Avonite, Inc.
   b. Dupont
   c. Formica Corporation.
   d. Nevamar Company, LLC; Decorative Products Div.
   e. Wilsonart International; Div. of Premark International, Inc.

2. Provide solid polymer material homogeneous cast, filled acrylic, not coated, laminated or of composite construction, complying with ANSI Z124.3 and ANSI Z124.6, Type six, and WIC “Manual of Millwork, Section 17, Countertops – Solid Surface.”
   a. Tensile Strength: 5,000 psi minimum, per ASTM D 638.
   b. Flexural Strength: 7,000 psi minimum, per ASTM D 790.
   c. Elongation: 0.3 percent minimum, per ASTM D 638.
   d. Hardness: 90-Rockwell “M” scale minimum.
   e. Color Stability: No change, 100 hours minimum, per NEMA LD3-3.10.
   f. Wear and Cleanability: Passes ANSI Z124.3.
   g. Abrasion Resistance: No loss of pattern, maximum weight loss (1,000 cycles) equal to 0.9 g, per NEMA LD3-3.01, ANSI Z124.3.
   h. Boiling Water Surface Resistance: No change, per NEMA LD3-3.05.
   i. High Temperature Resistance: No change, per NEMA LD3-3.06.
   j. Impact Resistance:
      1) (Notched Izod): 0.24 foot-pounds minimum, per ASTM D 256, Method A.
      2) (Gardner Ball Drop): 9.0 foot-pounds minimum per ASTM D 5420.
      3) 1/4-inch Sheet: 36 inches minimum, 1/2 pound ball, no failure per NEMA LD3-3.03.
      4) 1/2-inch Sheet: 140 inches minimum, 1/2 pound ball, no failure per NEMA LD3-3.03.
      5) 3/4-inch Sheet: 200 inches minimum, 1/2 pound ball, no failure per NEMA LD3-3.03.
      6) (Bowls – Point Impact): No cracks or chips, per ANSI Z124.3 and Z124.6.
   k. Strain Resistance: Passes ANSI Z124.3.
3. Thickness: As indicated on Drawings.
   a. For countertops, solid polymer material shall be fabricated by adhesively joining panels with inconspicuous seams.
   b. Edge details shall be as indicated on Drawings, fabricated by building up edges with bonded strips and finishing achieve inconspicuous lamination joints.

4. Color and Pattern: As selected by Architect from manufacturer’s full range of colors and patterns.
5. Joint Adhesive: Manufacturer’s standard two-part adhesive kit to create inconspicuous, non-porous joints with chemical bond.
6. Panel Adhesive: Manufacturer’s neoprene-based panel adhesive meeting ANSI A136.1, UL listed.
7. Joint Sealer: Silicone sanitary sealant, clear or white as selected by Architect, as specified in Section 07 92 00 “Sealants.”
8. Sink/Lavatory Mounting Hardware: Manufacturer’s bowl clips, panel inserts and fasteners for attachment of undermount sinks/lavatories.

F. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 Clear, Quality-Q3, with exposed edges seamed before tempering, 6 mm thick, unless otherwise indicated.

G. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Section 08 30 05 "Decorative Glass."

2.2 Panel Materials

A. Provide softwood plywood PS 1, standard sheathing grade, Group 1, appearance quality, Douglas fir with face veneer rotary cut, minimum 3/4-inch thick, intermediate exposure glue. Use only at concealed conditions provide Douglas fir plywood, thickness as indicated for casework or countertop construction, intermediate exposure glue at casework panels and exterior exposure glue for countertop substrates.

B. Provide hardwood plywood complying with HPMA standard, veneer (plywood) core, grade to suit WIC Grade specified for casework construction.
   1. Hardwood for opaque finish: “A” face of panel shall be rotary-sliced, minimum 1/26-inch thick, suitable for opaque finish.

C. Provide plywood base for hardwood veneer PS 1, close-grained species and grade complying with applicable provisions of WIC “Manual of Millwork” and details indicated on Drawings.

D. Provide plywood base for plastic laminate, close-grained hardwood plywood, ANSI/AHA 135.4, all hardwood plies, non-telegraphing faces, formaldehyde-free and complying with requirements for referenced WIC grade.
   1. Provide minimum thickness according to WIC quality standards as detailed on Drawings and as specified herein.
   2. Provide exterior grade product with waterproof glue (marine grade plywood) at countertop locations with plumbing fixtures.

E. Particleboard not permitted.
2.3 Anchors and Fasteners

A. Unless otherwise indicated, provide fasteners of type, grade and class required for intended use and sized and spaced as required for loads and substrate.

B. Select material, type, size, and finish required by each substrate for secure anchorage. Provide non-ferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.

1. For use at wood or metal stud walls, provide minimum #14 x 3” Phillips truss head, type 17 hard, zinc plated, self-tapping, full head screws. Select material, type, size and finish required for each use. Comply with applicable requirements of FS FF-S-111. For attachment to metal framing supports, provide screws as indicated on Drawings.

2. Provide Tite Joint Fasteners for countertop segment anchors.

C. For exposed anchors and fasteners provide same material, color and finish as the metal to which applied, except use only stainless steel at aluminum materials and use cadmium plated at interior pre-painted steel products.

D. Provide formaldehyde-free Type I fully waterproof contact adhesives.

E. Provide solvent release, cartridge type wall adhesive compatible with wall substrate, capable of achieving durable bond.

F. Fire-Resistive Adhesives:

1. For lumber and wood veneers provide Penacolite #G-1124 manufactured by Koppers, or equal.

2. For plastic laminates provide Penacolite #G-1124-A/G-1131-B manufactured by Koppers, or equal.

G. Provide rigid (urea, resorcinol) countertop segment adhesive, complying with requirements for WIC Type II water-resistant adhesive.

H. Do not use adhesives that contain urea formaldehyde.

I. Use adhesives that comply with required VOC Limits.

2.4 Cabinet Hardware and Accessories

A. Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Section 08 71 00 “Door Hardware.” Where hardware is not specified, provide hardware according to current WI approved hardware listing and as selected by contractor as suitable for project conditions, subject to review and acceptance by Architect.

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, Grade 2, 165 degrees of opening, self-closing.

C. Pulls: Back mounted, “u” shaped solid metal, 4 inches long, 5/16 inch in diameter; 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter, BHMA A156.9, B02011.

D. Catches: Magnetic catches, BHMA A156.9, B03141.

E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
F. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

G. Drawer Slides: BHMA A156.9, B05091.
   1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides. 200 lb.
   2. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
   3. Pencil Drawer Slides: Grade 2; for drawers not more than 3 inches high and 24 inches wide.
   4. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
   5. Trash Bin Slides: Grade 1HD-100; for trash bins not more than 20 inches high and 16 inches wide.
   6. Typical drawers: 1 HD-100, 100 lb.

H. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.

I. Locks:
   1. Door Locks: BHMA A156.11, E07121.
   2. Drawer Locks: BHMA A156.11, E07041.
   3. Provide locks at all drawers, single doors and on active leaf of paired doors.
   4. Provide 2 keys for each lock.
   5. Coordinate locks and latches specified below. At pairs of doors, active leaf shall have lock and inactive leaf shall have elbow catch.
   6. Assist Owner with developing a key schedule for drawer locks when shop drawings are reviewed. Coordinate with keying requirements specified in Section 08 71 00 “Door Hardware.” Integrate cabinet drawer and door locks with existing master key system.

J. Grommets for Cable Passage through Countertops: 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Subject to requirements, provide “TG Series” by Doug Mockett & Company, Inc., or approved equal.

K. Retracting Door Hardware: Accuride 1332 Anti-Rak flipper door slides with Anti-Rak cable, or approved equal, vertical retracting slide with hinge carrier strip and extra hinge; one hinge per foot of door height.

L. Drawer Stops: Provide stops to prevent drawer fronts from hitting face of cabinet body.

M. Computer CPU Mount: Workspace CPU holder as manufactured by Neutral by Design, or approved equal.

N. File Folder Supports: As suitable for Pendaflex file folders, chrome plated.

O. Elbow Catches: Ives IV2AM, aluminum, or approved equal. Coordinate locks and latches specified below. At pairs of doors, active leaf shall have lock and inactive leaf shall have elbow catch.

P. Magnetic Catches: Provide magnetic catches at all doors with locks and all doors without elbow catches, Amerock (National) No. 61-570, Stanley No. 41, or approved equal.

Q. Closet Poles: 1-1/16 inch diameter chrome plated steel, 14 gage minimum, with chrome plated steel pole sockets.
R. Cable Management Wire Ducts: MilesTek or approved equal, square shape wire duct, with factory-applied double-sided adhesive tape.
   1. Model: Catalog No. 70-50287.
   2. Color: Black.

S. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Stainless Steel: BHMA 630.

T. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

U. Provide silicone silencers on all drawers and doors.

V. Provide extruded convex shaped; smooth finish; self-locking serrated tongue plastic edge trim; of width to match particleboard shelving thickness; color as selected by Architect.

2.5 Miscellaneous Materials

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Select material, type, size, and finish of anchors required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.6 Fabrication

A. Unless otherwise indicated, provide the following grades of interior woodwork complying with referenced quality standard.
   1. Premium grade.

B. Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

D. Complete fabrication, including shop assembly, finishing, and hardware application, to maximum extent possible before shipment to project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting. 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 indicated on Shop Drawings before disassembling for shipment. Ease all edges to a 1/16 inch radius.
E. Shop-cut openings to maximum extent possible to receive hardware, 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. Seal edges of openings in countertops with a coat of varnish.

F. Fit and install cabinet hardware at the shop to the greatest extent possible. After cabinets are in place, readjust each hardware item and leave in correct working condition.

G. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA’s "Glazing Manual." For glass in wood frames, secure glass with removable stops.

H. Size and shorten back of cabinets to allow for utility valves and outlets as required. Provide openings in cabinet backs to access valves and outlets. Coordinate location of valves and outlets prior to fabrication.

2.7 Wood Casework for Opaque Finish

A. Grade: Premium.

B. WI Construction Style: Style A, Frameless.

C. WI Construction Type: Type I, multiple self-supporting units rigidly joined together.

D. WI Door and Drawer Front Style: Flush overlay.

E. Reveal Dimension: 1/2-inch.

F. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.

G. Panel Product for Exposed Surfaces: Medium-density fiberboard.

H. Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Match materials indicated for exposed surfaces.
2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

I. Provide dust panels of 1/4-inch clear plywood above compartments and drawers, unless located directly under tops.

2.8 Solid-Surfacing-Material Countertops

A. Grade: Premium.

B. Solid-Surfacing-Material Thickness: 3/4 inch.

C. Colors, Patterns, and Finishes: As selected by Architect from manufacturer’s full range.

D. Fabricate tops in one piece in shop, to greatest extent possible. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

1. Fabricate tops with shop-applied edges of materials and configuration indicated.
2. Fabricate tops with shop-applied backsplashes.
E. Install integral sink bowls in countertops in shop.

F. Drill holes in countertops for plumbing fittings, soap dispensers and other accessories in shop.

G. Conform to profiles and dimensions indicated on Drawings and reviewed shop drawings. Thicknesses shall not be less than minimum recommended by solid polymer material manufacturer and specified herein.

H. Form joints between components using manufacturer’s standard joint adhesive. Joints shall be inconspicuous in appearance and without voids. Attach 2 inch wide reinforcing strip of solid polymer material under each joint.

I. Make cutouts and holes for plumbing and other fixtures and fittings, as indicated on Drawings and to suit fixtures and equipment being furnished under separate contract by Owner. Route and ease all edges, then sand all edges smooth.

J. Finish all surfaces uniformly.

K. Repair or replace defective and inaccurate work.

L. Comply with manufacturer’s fabrication instructions and recommendations for countertop side and back splashes:
   1. Provide side and back splashes of heights as indicated on Drawings.
   2. Fabricate countertops with sinks and countertops subject to liquid spills, with 1/2-inch radius cove at intersection of countertop and backsplash and with no drip (marine) front edge.
   3. Form backsplash using 3/4-inch thick material.

M. Allowable Tolerances:
   1. Variation in component size: +/- 1/8 inch.
   2. Location of openings: +/- 1/8 inch from indicated location.

2.9 Closet and Utility Shelving

A. Grade: Custom.

B. Shelf Material: 3/4-inch solid lumber pine.

C. Cleats: 3/4-inch clear solid lumber pine.

2.10 Shop Finishing

A. Provide finishes of same grades as items to be finished.

B. Finish architectural woodwork at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
C. Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work. Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate.

D. Opaque Finish:
   1. Grade: Premium.
   2. WI Finish System 1b.: Acrylic lacquer.
   3. Color: As selected by Architect from manufacturer’s full range.
   4. Sheen: Semigloss, 46-60 floss units measured on 60-degree gloss meter per ASTM D 523.

2.11 Fire Characteristics of Plastic Laminate-Clad Casework and Countertops

A. Comply with CBC, Table 8-B, Class II in exitways and Class III in rooms and other areas.
   1. Class I: Flame spread 25 of less and smoke density 50 or less, when tested in accordance with ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.
   2. Class II: Flame spread 75 or less and smoke density 100 or less, when tested in accordance with ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.
   3. Class III: Flame spread 200 or less and smoke density not exceeding 450, when tested in accordance with ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.

B. Fabricate casework using fire-retardant particleboard with fire-rated high-pressure laminate facing, minimum 0.048 inch thick for horizontal conditions and minimum 0.039 inch thick for vertical conditions.

PART 3 - Execution

3.1 Examination

A. Before installing architectural woodwork, examine shop-fabricated work for correct fabrication and completeness including removal of packing and back priming. Make corrections as necessary.

B. Verify that surfaces and openings are ready to receive finish carpentry work.

C. Verify that mechanical, electrical and building items affecting work specified in this Section are placed and ready to receive this work.

D. Inspect casework before installation for damage. Verify that casework will fit in intended locations.

E. Inspect solid polymer fabrications for damage before installation. Verify that fabrications will fit in intended locations.

3.2 Preparation

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.
3.3 Installation

A. Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved. Installation shall comply with all applicable WI standards. All installation work shall be done under the supervision of a skilled cabinetmaker who can direct the installation in accordance with the true intent and meaning of drawings and specifications. He shall have had experience in fabricating and finishing of cabinetwork. All installation shall conform to standards as set forth in the WI Manual of Millwork, Section 1.

B. Assemble woodwork and complete fabrication at project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight to a tolerance of 1/8 inch in 96-inches with no variations in flushness of adjoining surfaces. Shim as required with concealed shims.
   1. Install toe kick bases first and level before setting casework bodies.
   2. Set and secure casework in place, straight, rigid, plumb, and level.
   3. Secure toe kick bases and casework to floor using appropriate angles and anchors.
   4. Secure casework at top and bottom to each wall stud or to backing in wall with 3 inch hex head, #14 self-drilling sheet metal screws, spacing fasteners at 16 inches on center maximum.
   5. Conceal anchorage devices where possible.
   6. Countersink exposed fasteners.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Make tight joints, constructed to conceal shrinkage. Miter all corners and angles at moldings and trim; except, at dimensional lumber miter exterior angles and cope interior angles and trim. Avoid running joints by using maximum practical lengths. Use single lengths at door and window frames and trim. Locate splices inconspicuously. Make no splices in lengths less than 72 inches.

F. Provide type and size of fasteners as indicated. Where not indicated, provide fasteners of type and adequate size and spacing for intended purposes. Obtain review of the Architect for fastenings as components weighing in excess of 20 pounds or subject to live loading. Use finish or casing nails at exposed locations. Use galvanized nails at exterior and damp interior locations. Provide blind nailing where practical.

G. Back prime all finish work indicated to receive opaque paint finish. At finish work to receive clear coating, coat back (back prime) with one coat of clear sealer. Back prime trim and boards exceeding 3 inches width. Back prime finish work at all exterior and damp locations.

H. Cover exposed edges of shelving and site-built casework with 3/8 inch thick hardwood edging. Width of edging shall match panel thickness.

I. Attach joining casework with fasteners and fastening methods to result in concealed attachments. Use threaded steel concealed joint fasteners to align and secure adjoining countertops.

J. Anchor woodwork to anchors or blocking built in or directly attached to suitable supporting substrates. Secure with concealed fasteners whenever possible and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

K. Install cabinets without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches on center with No. 10 wafer-head screws sized for 1-inch minimum penetration into wood framing, blocking, metal backing or metal framing behind wall finish. Provide type of anchor to match anchoring substrate.

L. Anchor countertops securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacing-material countertops and form tight invisible seams using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface. For solid surface countertops comply with manufacturer’s written recommendations for installation and joining.
2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
3. Calk space between backsplash and wall with sealant specified in Section 07 92 00 "Sealants."
4. Install undermount/submount/bevel mount lavatories and sinks, as applicable, using manufacturer’s recommended adhesive and mounting hardware.
5. Adhere topmount sinks/bowls to countertops using manufacturer’s recommended adhesives and color matched silicone sealant.
6. Make cutouts for fixtures to templates supplied by fixture manufacturer. Carefully locate cutouts for pipes so that edges of holes will be covered by escutcheons.

M. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.4 Tolerances

A. Maximum variation from true position: 1/16 inch.
B. Maximum offset from true alignment with abutting materials: 1/32 inch.

3.5 Preparation for Site Finishing

A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand surfaces smooth. Resawn and rough sawn lumber shall retain original texture.
B. Complete the finishing work specified in this Section to whatever extent not completed at shop or before installation of woodwork. Refer to Section 09 90 00 “Painting” for final field finishing of installed architectural woodwork.

3.6 Adjusting and Cleaning

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
B. Clean, lubricate, and adjust hardware. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly and correctly, without binding or squeaking.
C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas. Remove all marks, adhesive residue and soiling from all exterior and interior surfaces for dust free condition. Sanitary cleaning, if necessary, will be performed by Owner.
D. Clean countertops for completion review, using cleaning agents and procedures recommended by solid polymer sheet manufacturer. Use non-abrasive cleaners only.

E. Fabricator/installer shall provide a commercial care and maintenance video, review maintenance procedures and warranty details with Owner prior to completion review.

3.7 Field Inspections

A. If directed by project inspector or Architect, contractor shall request and schedule field inspection of completed installation by the Woodwork Institute (WI) in accordance with WI Reinspection Service Program.

B. Provide copies of infield inspection reports to project inspector and Architect.

3.8 Protection

A. Provide final protection and maintain conditions in a manner acceptable to fabricator and installer that ensures that woodwork is without damage or deterioration at time of Substantial Completion review.

END OF SECTION 06 40 00
SECTION 07 21 00 - Insulation

PART 1 - General

1.1 General

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

B. Related Sections include:

   1. Section 05 40 00 “Cold-Formed Metal Framing.”
   2. Section 07 92 00 “Sealants.”
   3. Section 08 11 13 “Steel Doors and Frames.”
   4. Section 09 22 16 “Non-Structural Metal Framing.”
   5. Section 09 53 23 “Suspended Ceilings.”
   6. Section 10 28 16 “Toilet and Bath Accessories.”
   7. Section 10 44 00 “Fire-Protection Specialties.”
   8. Division 22 Plumbing Sections.
   9. Division 23 Heating, Ventilating, and Air Conditioning Sections.
   10. Division 26 Electrical Sections.
   11. Division 27 Communications Sections.

1.2 Performance Requirements

A. Provide insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181.

   1. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 25000-fpm air velocity.
   2. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

B. Provide insulation materials with non-combustible components with a flame spread of 25.

1.3 Submittals

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

B. Samples:

   1. Submit one 12 x 12 sample of each type of insulation specified.
   2. Submit samples of required fasteners.

1.4 Quality Assurance

A. Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics. Identify materials with appropriate markings of applicable testing and inspecting agency.
B. Roof insulation shall have a flame spread rating not greater than 25 and a smoke developed rating not greater than 200, exclusive of covering, when tested in accordance with ASTM E 84.

C. Roof insulation anchorage shall conform to minimum FM-I-90 attachment requirements to metal decking for resistance to wind uplift.

D. Certification:
   1. Submit certification that insulation material and installation conform to requirements of CBC Title 24 Energy Compliance Regulations.

E. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

F. Coordinate with other Sections of work with regards to providing materials and installation for mockups.

G. Do not install insulation products of any kind when any water is present or substrates are damp or wet.

H. If unfaced insulation is used in applications where there is a potential for skin contact and irritation provide vapor barrier over insulation, fasten in place, to prevent contact.

I. Kraft and standard foil facings will burn and must not be left exposed. Protect facing from any open flame or heat source.

J. Provide materials, not specifically specified but required for a complete and proper installation of the work in this Section.

1.5 Delivery, Storage and Handling

A. Deliver materials to site in manufacturer’s unopened and undamaged original commercial containers bearing the following legible information:

   1. Name of manufacturer.
   2. Brand designation.
   3. Specification number, type, and class, as applicable, where materials are covered by a referenced specification.
   4. Asphalt flashpoint (FP), equiviscous temperature (EVT), and finished blowing temperature (FBT).
   5. R value, if applicable.
   6. Production date or product code.

B. Store and handle materials in a manner to protect from damage, exposure to open flame or other ignition sources, and from wetting, condensation or moisture absorption. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment. Store materials off ground. Protect against weather, condensation, and damage. Replace damaged material with new material. Store board materials flat on pallets. Cover materials with waterproof tarp.

1.6 Scheduling

A. Coordinate installation with placement and fitting with work specified in other Sections.

B. Do not install insulation until construction has progressed to the point that inclement weather will not damage or wet the insulation material.
C. Install insulation after electric wiring, plumbing, and other concealed work is in place.

D. Insulation shall not be closed in until it has been inspected and approved.

PART 2 - Products

2.1 Glass-Fiber Blanket Insulation

A. Subject to requirements, provide products by one of, or equal to the following:

1. CertainTeed Corporation.
2. Johns Manville.
3. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Use only approved plenum rated insulation types where exposed to plenum ceiling areas.

C. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III blankets with foil facing with flame spread index of 25 or less. Use only approved plenum rated insulation types where exposed to plenum ceiling areas. Provide for foil faced formaldehyde free.

D. In addition to locations indicated on Drawings, provide at all interior walls and partitions including shaft walls, utility rooms, electrical rooms, toilet rooms and mechanical rooms. Provide above all restroom ceilings.

E. Provide blankets in batt or roll form with thermal resistances indicated.

2.2 Vapor Retarders

A. Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim. Subject to requirements, provide products by one of, or equal to the following:

1. Raven Industries Inc.; DURA-SKRIM 6WW.

B. Provide pressure-sensitive tape recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

D. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, and Use NT related to exposure, and Use O related to vapor-barrier-related substrates.

E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

2.3 Insulation Fasteners

A. Provide all necessary staples, tape, wires and other needed fasteners necessary and needed to fasten and support insulation as recommended in writing by insulation manufacturer.
B. Retainer / Impaling Clips for Insulation: Galvanized steel Z-clips designed for supporting insulation, and as recommended in writing by insulation manufacturer.

PART 3 - Execution

3.1 Examination and Preparation

A. Surfaces and cavities shall be clean, smooth, and dry. Check surfaces, including surfaces sloped to drains and outlets, for defects before starting work. Inspect the surfaces immediately before starting installation.

B. Verify mechanical, plumbing and electrical systems within the above ceiling space have been tested and inspected.

C. Correct defects and inaccuracies in existing surfaces prior to proceeding with insulation work. Proceeding with insulation work constitutes acceptance of substrate conditions by contractor.

3.2 Installation, General

A. Comply with insulation manufacturer's written instructions applicable to products, conditions and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement. Place insulation so voids are completely filled and so insulation makes full contact with surfaces on all sides of void. Place insulation so insulation facings make substantial contact with finish board or panel.

D. If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and so that insulation encapsulates and surrounds piping.

E. Install batts with close fit, free of gaps, holes, or sagging. Supplement the installation with wire ties, adhesive, spindle anchors, or staples where required by manufacturer’s written requirements to prevent sagging. Provide spindle anchors where shown or necessary in accordance with manufacturer’s instructions, spaced at maximum 12-inch centers both ways.

F. Insert batts between ceiling joints and fill entire cavity, so that top of insulation is level with top of framing members and face is snug with finish material. Do not install insulation over recessed lighting fixtures, speakers, or other heat producing elements in the ceilings. At junction boxes, access panels and other items requiring access above or below the ceiling, cut insulation on each side to fit the item and install loosely on top. Fit insulation snugly around ducts, conduits, pipes and other items projecting through the ceiling construction.

G. Install acoustic insulation continuously between studs from finish floor to top of wall. Where cutouts are made for J-boxes, conduit, piping, and like items, back wall insulation with insulation so that one additional layer of insulation at least 24 inches wide and high is placed in back of cutout. Snugly fit in place free of gaps or holes.

H. Fill around all penetrations with insulation.

I. Fit insulation around ducting, piping, wiring and other obstructions.

J. Stagger end joints between studs and between planes of multi-layer insulation.
K. Fill entire width of cavity between framing members with insulation.

L. Trim insulation neatly to fit non-standard framing cavity widths.

M. Cover top side of interior ceilings with acoustical insulation where indicated on the Drawings.

3.3 **Installation of Building Insulation**

A. Apply insulation units to substrates by method complying with manufacturer's written instructions.

B. Seal joints between EPS insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed EPS installation with adhesive, mastic, or sealant as recommended by EPS insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder which will be to the warm side of the completed construction in location indicated. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install glass-fiber insulation in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends. Place insulation so that voids are completely filled and so insulation makes full contact with surfaces on all sides of insulation.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members. If cavity is less than 96 inches in height or length, cut insulation to friction-fit.
   3. Maintain 3-inch clearance between insulation and recessed lighting fixtures.
   4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   5. For metal-framed wall provide friction-fit batts tightly fitted to stud webs and to metal furring after cover material has been installed on one side of the cavity. When unfaced insulation is used, and in applications without a cover material or where the stud depth is larger than the insulation thickness, use wire or metal straps to hold insulation in place. When faced insulation is used, the attachment flanges may be taped to the face of metal stud prior to applying the interior finish.
   6. Carefully cut to fit insulation around outlets, junction boxes and other irregularities and penetrations.
   7. Where walls are not finished on both sides or insulation does not fill the cavity depth, supplementary support as recommended by insulation manufacturer must be provided to hold product in place.
   8. Where insulation extends longer than 8 feet provide temporary support to hold product in place until the finish material is applied.

3.4 **Installation of Vapor Retarders**

A. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Extend vapor retarder to cover miscellaneous voids in insulated substrates.

B. Seal vertical joints in vapor retarders over framing by lapping not less than two framing members. Fasten vapor retarders to framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches on center.
C. Before installing vapor retarder, apply urethane sealant to framing including runner tracks, plates, studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to framing and solid substrates with mechanical vapor-retarder fasteners as recommended by vapor-retarder manufacturer. Maintain vapor retarder integrity by tightly abutting adjacent sections of retarder. Repair punctures or tears in vapor retarder facing by taping. Follow tape manufacturer's application recommendations.

E. Seal penetrations 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 retarder.

F. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder with all edges completely sealed with sealing tape.

3.5 Protection

A. Remove work and materials that become damaged or wet during construction. Replace with new materials.

END OF SECTION 07 21 00
SECTION 07 84 00 - Through-Penetration Firestop Systems

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 07 21 00 “Insulation.”
3. Section 07 92 00 “Sealants.”
4. Section 09 22 16 “Non-Structural Metal Framing.”
5. Section 09 29 00 “Gypsum Board.”
6. Division 21 Sections specifying fire-suppression piping.
7. Division 23 Sections specifying duct and piping.
8. Division 26 Sections specifying cable and conduit.

1.2 Performance Requirements

A. For penetrations through fire-resistance-rated constructions, including both blank openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. Provide through-penetration firestop systems with the following ratings determined per UL 1479.

1. Where applicable provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
2. Where applicable provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.
3. Where applicable provide through-penetration firestop systems with L-ratings indicated of not more than 3.0 cfm/sq. ft. at both ambient temperatures and 400° F.
4. Where applicable provide products that meet the intent of the W-rating classification for passage of water per ANSI/UL 1479 for through-penetrations.

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. Conform with the following Standards:

2. ASTM E 814 and UL 1479, Fire Tests of Through-Penetration Fire Stops.
3. ASTM C 719, Adhesion and Cohesion of Elastomeric Joint Sealant under Cyclic Movements.

F. Association: Manufacturer shall be a member or be approved by the “International Firestop Council.”

G. Provide firestop products that are flexible enough to allow for pipe vibration in a through-penetration application.

H. Provide products that bear classification marking of qualified independent testing agency.

I. Where firestop system is not listed by any listing agency as required due to project conditions, submit a substitution proposal with evidence specified.

J. Use only products specifically listed for use in listed systems.

K. Provide products that meet the intent of the state or local regulations on volatile organic compounds (VOC).

1.3 Submittals

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

1. Manufacturer’s product description and specifications.
2. Building Authority approvals or approval references.
3. Test reports indicating system compliance with requirements of this Section.
4. Manufacturer’s mixing, installation instructions and details.
5. Manufacturer’s storage and handling requirements.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction and type of penetrating item. Include firestop design designation of qualified testing agency that evidences compliance with requirements for each condition indicated.

1. Listing agency’s detailed drawing showing opening, penetrating item(s), and firestopping materials, identified with listing agency’s name and number or designation and fire rating achieved.
2. Where project conditions require modification to a particular through-penetration firestop condition, submit engineering judgment drawings, with modifications marked, based on International Firestop Council practices, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Submit and obtain approval by authority having jurisdiction.

C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

D. Samples: 12-inch by 12-inch for sheet goods, 12-inches-long for rolled and sealant products and actual product samples for all others.

1.4 Quality Assurance

A. Provide an installer who specializes in the installation of firestopping systems and that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors," and 5 years minimum documented experience installing through-penetration firestop systems similar in material, design, and extent to that indicated for this project, and whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to contractor or to installer engaged by contractor does not in itself confer qualification on buyer.

1. Installer shall meet all certification and qualification requirements of manufacturer of firestopping material and be certified by manufacturer.
2. Installer is acceptable to authorities having jurisdiction.
3. Installer has completed the manufacturer’s certified product installation training.

B. Assign installation responsibility of through-penetration firestop systems and fire-resistant joint systems in project to a single qualified installer.

C. All firestopping and smokestopping products shall be from a single manufacturer throughout the project, regardless of system or trade responsible for the penetrating components through the fire or smoke barrier. Manufacturer shall have a minimum 10 years documented experience in the manufacture and distribution of through-penetration firestopping products.

1. Products shall be manufactured in a facility that follows ISO 9001 best practices.
2. Products shall have undergone a formal life cycle assessment evaluating environmental impact.


E. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

F. Firestopping manufacturer’s representative shall be onsite during installation of firestop systems. Representative to issue report stating that firestopping installation meets manufacturer’s written requirements and requirements of UL Fire Resistance Directory requirements.

G. Firestopping systems do not re-establish structural integrity of an assembly.

H. Conform to building Code requirements for fire penetration seals and smokestopping. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings as required by authorities having jurisdiction. All firestopping and smokestopping products shall be governed by current ICC Evaluation Service (ICC ES) Evaluation Report, as acceptable to authorities having jurisdiction. Where
manufacturer’s application procedures are in conflict with requirements of authorities having jurisdiction, the more strict requirements apply.

1.5 Delivery, Storage, and Handling

A. Deliver through-penetration firestop system products to project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, listing agency's classification marking applicable to project, curing time, and mixing instructions for multicomponent materials. Coordinate delivery of products to minimize storage time at site.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, direct sunlight and UV exposure or other causes. Follow manufacturer’s instructions.

C. Dispose of through-penetration firestop materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.

1.6 Project Conditions

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturer’s written recommendations, or when substrates are wet due to rain, frost, condensation, or other causes. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install firestopping under environmental conditions outside manufacturer’s absolute limits.

B. Provide ventilation of through-penetration firestop systems per manufacturer's written instructions.

1.7 Coordination

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements and required ratings. Coordinate with other trades to assure that firestop penetration materials and assemblies are installed at a time and manner that fits with sequence of work and does not delay work of other trades. Perform firestopping and smokestopping work after completion of work which penetrates fire and smoke barriers, but prior to covering up or eliminating access to the penetration.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspector at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner’s inspector, and building inspector, if required by authorities having jurisdiction.

1.8 Warranty

A. Provide written warranty for a period of 2 years that through-penetration firestopping will not fail or become displaced under operating conditions normal to the building.
PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

2. Hilti, Inc.
3. 3M; Fire Protection Products Division.
4. Tremco; Sealant/Weatherproofing Division.
5. USG Corporation.

2.2 Firestopping, General

A. Provide through-penetration firestop systems and components that are compatible with one another; compatible with the substrates forming openings; and compatible with penetrants, if any, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience. Provide firestop systems that are unaffected by water. Do not use firestop materials that contain solvents.

B. Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials.
2. Temporary forming materials.
5. Steel sleeves.

C. All firestopping and smokestopping materials, assemblies and installation details shall comply with all applicable codes and requirements of authorities having jurisdiction, including the Building Official and the Fire Marshal having jurisdiction over the facility.

D. It shall be the contractor’s responsibility to determine the types of penetrations and gaps to be sealed and to select appropriate firestopping and smokestopping system designs.

E. Provide products which:

1. Allow normal expansion and contraction movement of the penetrating or adjoining elements without failure of the penetration or gap seal.
2. Emit no hazardous, combustible, or irritating by-products during installation or curing period.
3. Do not require special tools for installation or maintenance, including removal and reinstallation of firestopping or smokestopping products to accommodate addition or deletion of penetrating components.

F. Where gunnable or pourable sealant is used, provide only fully-curing types of sealant where penetration accessible in the finished work.

G. Provide firestopping materials and assemblies to seal all penetrations at all fire barriers. Firestopping assemblies shall be listed in the UL Fire Resistance Directory under categories XHCR and XHEZ, providing that such assemblies conform to the construction type, penetration type, annular space...
requirements and fire rating requirement for each distinct condition, and that the system shall be symmetrical for wall applications.

1. Fire resistance ratings of each firestopping assembly shall be determined by testing in the configurations necessary for project conditions and fire resistance ratings shall be at least as high as that of the fire barrier in which the firestopping assembly is installed.

2. If a tested assembly is not available for a particular penetration configuration, modify the penetration configuration to suit available assemblies, as acceptable to authorities having jurisdiction. Do not modify assembly configuration except as specifically stated in the test report or as approved by authorities having jurisdiction.

H. Provide firestopping materials and assemblies to seal all gaps between building elements at all fire barriers. Firestopping assemblies shall be listed in the UL Fire Resistance Directory and shall conform to the construction type, type of gap and fire rating requirement for each distinct condition.

I. Provide firestopping assemblies to seal all penetrations at all smoke barriers. Sealing materials shall be any firestopping assembly using the same materials as used for firestopping in fire rated construction, specified above, provided that such assembly includes rating as a smoke seal and is acceptable to authorities having jurisdiction. Fire resistance time may be disregarded.

2.3 Fill Materials

A. Provide through-penetration firestop systems containing the types of fill materials required for Through-Penetration Firestop Systems indicated on drawings. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at project site to form a nonshrinking, homogeneous mortar.

I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
2. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

L. For cast-in-place concrete applications, provide Presealed Systems Hydroflame or approved equal.

M. Prefabricated Cable Penetration Seal: Hilti CP 653 speed sleeve.

2.4 Warning Labels

A. Provide mechanically fastened warning labels indicating that penetration or gap has been sealed with firestopping or smokestopping and providing pertinent information about such firestopping or smokestopping.

1. Label shall be as acceptable by authorities having jurisdiction, including size of label, size of lettering and color of lettering.
2. At a minimum, label shall include:
   b. Product used for sealing penetration gap.
   c. Listing agency’s system number or designation.
   d. UL classification number.
   e. Hour rating, if fire barrier.
   f. Date of installation.
   g. Firestop system manufacturer’s name, address and phone number.
   h. Installer’s name, address and phone number.
   i. General contractor’s name, address and phone number.

2.5 Fire Safing Insulation

A. USG Interiors, Inc., or approved equal.

B. ASTM E 119 and E 136, semi-rigid mineral fiber (paperless), USG Thermafiber Fire Safing Insulation.

C. Thickness: As required for fire safing rating.

1. Density: 4 pcf.

D. Fire Hazard Clarifications:

1. Fire Spread: 15.
2. Fuel Contributed: 0.
3. Smoke Developed: 0.

E. Fire Resistance: 3 hours at 2000°F.

F. Provide clip fasteners, split-prong galvanized steel accessories, as recommended by insulation manufacturer.
PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions, with installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work. Verify that penetration openings comply with listing requirements.

B. Conduct inspection jointly with authorized representative of authority having jurisdiction.

C. Verify substrates have been properly prepared.

D. Conduct tests according to manufacturer’s written requirements to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.

E. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.

F. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.

G. Verify that environmental conditions are safe and suitable for installation of firestopping.

H. If the configuration of a particular penetration or opening does not conform to the configuration necessary for the required firestopping or smokestopping design, notify the installer of the penetration for modification of the configuration to suit the assembly.

I. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation of firestopping materials indicates acceptance of substrates.

3.2 Preparation

A. Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer’s written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.
4. Remove construction markings.
B. Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

D. Test for staining and leaching of exposed surfaces by fire stopping materials, including but not limited to sealants, primers, fill materials, or masking tapes will not be acceptable. Test materials and surfaces for staining prior to installation of firestopping materials.

3.3 Through-Penetration Firestop System Installation

A. Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and in strict conformance with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and securely adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Remove combustible forming materials, unless they are a required component of the tested assembly.

3.4 Firesafing Insulation Installation

A. Provide firesafing insulation at locations where FIRE SAFING INSULATION or similar notation or graphic indication is shown on Drawings.

1. Provide firesafing insulation to fill cavities at penetrations through time-rated fire resistive concrete, masonry, steel and wood frame construction to provide smoke seal, except where intumescent firestopping system is sued.
2. Provide firesafing insulation to fill voids too large to be filled by endothermic firestopping sealant.

B. Fill cavities of frame construction at building area separation and seismic joints, using 16 inch wide firesafing insulation, to fire stop cavities. Install firesafing insulation at intervals not to exceed ten feet vertically and horizontally.

C. Seal top of firesafing insulation-filled joints expected to receive traffic loads and requiring finishing, except separation joints intended to experience seismic movement, with 2 inches of non-shrink grout.
3.5 Identification

A. Identify through-penetration firestop systems with preprinted metal labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners.

3.6 Field Quality Control

A. Owner will engage a qualified, independent inspector to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports. Notify testing agency at least 7 days prior to the date when firestopping installation will be ready for inspection; coordinate installation and inspection timing with work of other trades and obtain testing approvals in advance as required to allow subsequent construction to proceed on schedule.

B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. Obtain the approval of the authority having jurisdiction and manufacturer of firestopping materials. Notify authorities having jurisdiction when firestopping installation in ready for inspection; coordinate installation and inspection timing with work of other trades and obtain approvals in advance as required to allow subsequent construction to proceed on schedule.

3.7 Cleaning and Protecting

A. Clean up excess materials adjacent to openings as work progresses by methods and cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur. Remove left over material and debris from work area.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.8 Through-Penetration Firestop System Schedule

A. UL-classified systems are indicated and scheduled on the drawings; they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.

END OF SECTION 07 84 00
SECTION 07 92 00 - Sealants

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 07 84 00 “Through-Penetration Firestop Systems.”
2. Section 08 11 13 “Steel Doors and Frames.”
3. Section 08 80 00 “Glazing.”
4. Section 09 29 00 “Gypsum Board.”
5. Section 09 30 00 “Tile.”
6. Section 09 53 23 “Suspended Ceilings.”
7. Section 09 65 00 “Resilient Flooring.”
8. Section 09 90 00 “Painting.”
9. Section 10 11 00 “Visual Display Units.”
10. Section 10 14 00 “Signage.”
11. Section 10 22 39 “Folding Panel Partitions.”
12. Section 10 28 16 “Toilet and Bath Accessories.”
13. Section 10 44 00 “Fire-Protection Specialties.”
14. Section 12 34 50 “Institutional Casework.”
15. Division 22 Plumbing Sections.
16. Division 23 Heating, Ventilating, and Air Conditioning Sections.

1.2 Definitions

A. Type S: Products finished prepackaged which no job-site mixing is required.

B. Grade P: Products having sufficient flow to fill joints in horizontal surfaces and remain level and smooth at temperatures as low as 40° F.

C. Grade NS: Nonsag sealant that permits application in joints on vertical surfaces without sagging or slumping when applied at temperatures between 40° F and 122° F.

D. Use T: Classifies sealants designed for joints in surfaces subject to pedestrian and vehicular traffic.

E. Use NT: Classifies sealants designed for nontraffic exposure.

F. Use M, G, A: Refers to sealants which remain adhered, within given parameters, to various standard specimens.

G. Use O: Refers to substrate materials other than M, G, and A.

1.3 References


1.4 Performance Requirements
A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates, where indicated and specified.

B. Staining of adjacent and surrounding materials and leaching by sealant or primer is not acceptable. All stained materials must be cleaned to show no visible evidence of sealant or primer staining or leaching, or removed and replaced. Where doubt about staining exists, test a sample of material in question.

C. Provide sealants that are compatible with all building underlayments, paints, coatings, and waterproofing. Coordinate with work of other sections to determine compatibility with all materials that sealants contact. Assure compatibility where multiple types of sealants come in contact with each other.

D. Each sealant shall be validated by SWRI’s Sealant Validation Program.

1.5 Submittals

A. Product Data: For each sealant product indicated, include instructions for joint preparation and joint sealer application. Note all deviations from SWRI recommendations.

B. Shop Drawings: Indicate detailing of each type of sealant joint, indicating joint dimensions, materials, sealant profile, and size limitations.

C. Samples: For each type and color of joint sealant required, provide samples with actual joint sealants in 1/2 inch wide joints formed between two 6-inch-long by 6-inch-wide squares of material identical to the exposed surfaces adjacent to joint sealants. Include backing material.

1.6 Quality Assurance

A. Provide installer who is approved or licensed by sealant manufacturer for installation of elastomeric sealants required for this project, and who has completed 5 years minimum continuous, documented joint sealant application similar in materials, scope and extent to the work indicated.

B. Obtain each type of joint sealant through one source from a single manufacturer. Provide sealant from a manufacturer with a minimum of 10 years of experience in the manufacturing and distribution of sealant materials similar in type to sealants required.

C. Comply with the following:

1. ASTM C 919 – Practice for use of sealants in acoustical applications.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to project joint substrates as follows:

1. Locate test joints on project as directed by sealant manufacturer.
2. Conduct field tests for each type of sealant and application indicated.
3. Notify Architect and inspector seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with sealant manufacturer's technical representative present. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193. Prepare substrates and apply primers as recommended in writing by sealant manufacturer for each type of substrate to be tested. 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.
5. Report whether sealant failed to adhere to substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained. Submit written report of testing to Owner, Architect and Inspector of Record.

6. 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. Remove failing sealants in their entirety.

E. Coordinate sealant requirements for mock-ups required for work of other sections. Participate in construction of mockups of other sections. Provide all necessary materials and labor for sealant joints required for mockups. Test sealant joints in mockups for weatherproofing, sealant adhesion, joint movement and durability. Do not proceed with sealant work until mockup is approved by Architect. Rework mockups as necessary to obtain approval.

F. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract. Discuss at least the following items:

1. Submittals and sealant application schedule.
2. Surface condition, weather conditions and substrate preparation.
3. Sequencing of installation and coordination with work of other trades.
4. Installation methods and requirements.
5. Protection of work.
6. Installation of elements to be sealed and substrate preparation.
7. Application of curing agents, sealers, coatings, paint, and other materials to substrates and sealants.
8. Approved mockup to be used as a measure of acceptance.
9. Weather conditions forecast.
10. Other items related to successful execution of work.


1.7 Delivery, Storage and Handling

A. Deliver materials in original, tightly sealed unopened containers or packages with manufacturer’s name, labels, product identification, lot numbers, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer’s instructions and recommendations, to prevent their deterioration or damage due to moisture, high and low temperatures, contaminants, or other causes. Store materials out of weather in original containers or unopened packages as recommended by manufacturer.

C. Store materials off ground and under cover to prevent damage or contamination to materials by water, freezing, foreign matter or other causes. Promptly remove from site any materials which show evidence of damage or which shelf life has expired, and immediately make all replacements necessary at no additional cost or time to Contract.

D. Handle, store, and apply materials in compliance with applicable Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), volatile organic compound (VOC), and other regulations and manufacturer’s safety data sheets (MSDS).

1.8 Project 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 sealant manufacturer or are below 40° F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
5. When cementitious substrates are not thoroughly cured and dry.

B. Do not install solvent curing sealant in enclosed building spaces.

C. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

D. Sequence installation of joint sealers to occur not less than 21 or more than 30 days after completion of waterproofing, unless otherwise indicated.

E. Use silicone sealants only in applications recommended by manufacturer. Unless otherwise indicated in submitted product data, do not use silicone sealant for:

1. Below-grade applications.
2. Surfaces to be immersed in water for prolonged time.
4. Structural glazing.
5. Surfaces subject to abrasion and abuse.
6. Medical and pharmaceutical applications.

F. When applied to brass, copper, and zinc-containing metal substrates, verify that sealant will not cause corrosion prior to application.

G. Do not apply in totally confined spaces without ventilation for curing.

1.9 Warranty

A. Provide warranty in which sealant installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section and when sealants fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure for a period of 10 (ten) years.

1. Water leakage through sealed joints.
2. Adhesive or cohesive failure of sealant.
3. Staining of adjacent surfaces caused by migration of sealant or primer.
5. Chalking or visible color changes of cured sealants.

B. Provide warranty in which sealant manufacturer agrees to furnish and replace sealant materials that fail to comply with performance and other requirements specified in this Section for a period of 10 (ten) years.

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural 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 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Dow Corning Corporation.
2. General Electric Co.
3. Pecora Corporation.
4. Sonneborn Building Products Division / ChemRex, Inc.
5. Tremco, Inc.

2.2 Materials, General

A. 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 sealant manufacturer, based on testing and field experience. Provide joint sealants that are compatible with all flashings, underlayments and waterproofing.

B. Provide sealants and sealant primers that comply with VOC content requirements by authorities having jurisdiction.

C. Colors of exposed sealants will be as selected by Architect from manufacturer’s full range including custom colors. Multiple colors will be required, to suit various finish materials.

D. Elastomeric sealants shall be nonstaining to all substrates. Provide products that have undergone testing according to ASTM C 1248 and have not stained joint substrates indicated for project.

E. Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 1.77.2600.

F. In wet areas provide mildew resistant sealants.

G. Provide products that are permanently flexible.

H. Provide heat resistant sealant in areas affected by a rise in temperature.

I. All sealants in horizontal walking/pedestrian traffic areas shall be traffic bearing, non tracking with a stone hardness of 40-50.

J. Furnish sealants that remain durable when subjected to intense actinic (ultraviolet) radiation.

K. Furnish sealants that are color fast and resist color change.

L. Comply with ASTM C 920, including those references for type, grade, class and uses.

2.3 Backing

A. Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
B. Provide ASTM C 1330, Type C closed-cell, mildew resistant, non-migratory, non-outgassing, non-staining cylindrical sealant backings with a surface skin as recommended in writing by sealant manufacturer, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Provide polyethylene tape for joints too shallow to allow use of foam rod.

C. Provide polyethylene bond breaker adhesive tape or other plastic tape recommended in writing by sealant manufacturer to prevent sealant from adhering to joint surfaces where such adhesion would result in sealant failure.

2.4 Miscellaneous Materials

A. Provide primers recommended in writing by sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction sealant-substrate tests and field tests.

B. Provide cleaners for surfaces, 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. Provide nonstaining, nonabsorbent masking tape compatible with joint sealants and surfaces adjacent to joints.

D. Cleaning Cloths: Clean soft absorbent, lint free, cloths.

PART 3 - Execution

3.1 Examination

A. Examine joints indicated to receive joint sealants, with contractor, installer and sealant manufacturer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting sealant performance and warranty requirements.

B. Inspect substrates to receive silicone sealant. Ensure surfaces are clean, dry, and free of frost, dust, dirt, grease, oil, curing compounds, form release agents, laitance, efflorescence, and mildew. Metal surfaces should be smooth without pits, serrations, slots and other irregularities.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of substrates and conditions by contractor, installer and manufacturer.

3.2 General

A. Prepare substrates and apply sealant in accordance with manufacturer’s written instructions.

B. Handle and apply sealant materials in a manner that complies with regulations of jurisdictions having authority.

C. Do not use sealants in below grade applications, in areas of water immersion or on materials bleeding oils, plasticizers and solvents.

D. When applying sealants to metal and zinc coated substrates verify that sealant will not cause discoloration or corrosion.

E. Allow sealants to fully cure before concealing within elements of construction.
F. Complete horizontal joints prior to vertical joints. Lap vertical joint sealant over and onto horizontal sealant.

G. Do not install silicone sealants during inclement weather or when such conditions are expected; or when conditions are outside sealant manufacturer’s written recommended temperature and humidity ranges.

3.3 Preparation

A. Rake, brush and thoroughly clean substrates immediately before installing joint sealants to comply with 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), curing compounds, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, frost, soap residue, soil or other sealing compounds.

2. Clean porous joint substrate surfaces by bead or water blast cleaning, 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. Make sure that apparently clean surfaces are not covered with a thin film of dust. Clean alkaline from surface of concrete and CMU.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Do not flood surfaces with cleaners and solvents. Do not allow solvent film to accumulate on surfaces.

5. Conform to written instructions from sealant manufacturer where sealants are required to be applied over painted, lacquered, or waterproofed surfaces, or surfaces which have been treated with water-repellant or other coatings.

B. Prime joint substrates, where recommended in writing by sealant manufacturer and based on preconstruction sealant-substrate tests or prior experience. Apply and dry primer to comply with sealant manufacturer's written instructions. Confine primers to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces. Apply sealant same day surfaces are primed. Do not apply primer to sealant joint backing.

C. Use masking tape to create neat sealant lines and where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Do not allow masking tape to touch clean surfaces to which sealant will adhere. Remove tape immediately after tooling without disturbing joint seal.

D. Joint spaces and surfaces shall be thoroughly clean and dry at the time of installation of sealant materials. Do not install sealant material during or after rain or fog.

3.4 Installation of Sealants

A. Comply with sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. For general sealant installation comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. For acoustical sealant application standards, comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
D. Install sealant backings 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 sealant backings that have become wet before sealant application and replace them with dry materials.
4. Install joint backing so that joint depth is 50 percent of joint width, but a minimum of 1/4 inch deep, and a maximum of 1/2 inch. Use gage to ensure uniform depth to achieve correct profile, coverage and performance.
5. Install backer in straight sections, from corner to corner. Do not bend backer around corners, miter backer material at corners. Compress backer sections at ends to avoid pull back.
6. Install bond breaker on back side of joint where backing is not feasible.

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 in continuous ribbons without gaps or air pockets. Use sealant dispensing equipment to push sealant bead into openings.
2. Completely fill recesses in each joint to full and proper configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Do not allow sealants to overflow confines of joint or onto adjoining work.
4. Sealant shall be bonded to the 2 opposite sides of joint only.
5. Apply sealant under sufficient pressure to fill voids.
6. Install each sealant bead in one continuous operation to provide uniform, continuous ribbons without gaps or air pockets, and with complete wetting of the joint surfaces equally on opposite sides. Fill joints to slightly concave surface just below adjacent surfaces.
7. Parapet copings shall be double caulked at all joints exposed to weather.
8. Do not allow sealants or other compounds to overflow, spill or migrate into voids of adjacent construction.

F. Immediately after sealant application and before skinning or curing begins, tool sealants with metal spatula according to requirements specified 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 disolor or damage sealants or adjacent surfaces.
3. Tool sealant within time limits recommended in writing by sealant manufacturer in one continuous stroke to a slightly concave joint configuration slightly below adjoining surfaces per Figure 5A in ASTM C 1193, unless otherwise indicated.
4. Where sealant joints occur between horizontal and vertical surfaces fill joint to form a slight cove so that joint will not trap and pool moisture and dirt. Tool horizontal joints prior to vertical joints. Lap vertical sealant over horizontal sealant.
5. Use masking tape to protect surfaces adjacent to recessed tooled joints.
6. Remove masking tape immediately after tooling and before sealant skin forms (within 5 – 10 minutes.)
7. Remove excess uncured sealant within 10 minutes of application, remove uncured excess sealant with solvent-dampened cloth, wearing solvent resistant gloves. Carefully cut or scrape away completely cured excess sealant.
G. Coordinate with other trades to ensure installed sealant is not painted as part of other construction operations unless type is specifically formulated for paint.

3.5 Curing

A. Cure sealants in accordance with sealant manufacturer’s printed instructions to obtain high early bond strength, internal cohesive strength and durability.

3.6 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 that do not adversely affect substrates. Do not allow cleaning materials or solutions to come in contact with joint sealant proper. Restore all finishes to original condition. If surfaces adjoining joints are stained and cleaning is not acceptable, remove the affected work and provide new work as directed and approved, at no additional cost to Owner.

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

3.8 Sealant Schedule

<table>
<thead>
<tr>
<th>Application</th>
<th>Sealant Description</th>
<th>Type</th>
<th>Grade</th>
<th>Class</th>
<th>Exposure Use</th>
<th>Substrate Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior joints between plumbing fixtures, walls, floors and counters</td>
<td>Single component mildew resistant neutral curing silicone sealant</td>
<td>S</td>
<td>NS</td>
<td>25</td>
<td>NT</td>
<td></td>
</tr>
<tr>
<td>Perimeter joints between interior wall surfaces and door and window frames</td>
<td>Latex sealant comply with ASTM C 834</td>
<td>P</td>
<td>NF</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

END OF SECTION 07 92 00
SECTION 08 11 13 - Steel Doors and Frames

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 07 21 00 “Insulation.”
3. Section 07 92 00 “Sealants.”
4. Section 08 71 00 “Door Hardware.”
5. Section 08 80 00 “Glazing.”
6. Section 09 22 16 “Non-Structural Metal Framing.”
7. Section 09 29 00 “Gypsum Board.”
8. Section 09 90 00 “Painting.”
9. Section 10 14 00 “Signage.”
10. Division 26 Electrical Sections for electrical connections including conduit and wiring for door controls and operators.

1.2 Quality Requirements

A. Comply with SDI, ASTM, HMMA, UL, ANSI, NAAMM requirements.

1.3 Submittals

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, technical data, and finish information.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples:

1. For each type of exposed finish required, prepared on samples of not less than 3 by 5 inches.
2. For the following items, prepared to demonstrate compliance with requirements for quality of materials and construction:

   a. Doors: Show door panel, vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing louvers and glazing if applicable. 12 inches by 12 inches.
b. Frames: Show profile, corner joint construction, floor and wall anchors, and silencers. Include separate sections for fixed hollow metal panels and glazing if applicable. 24 inches long.

D. Schedule:

1. Provide a schedule of metal doors and frames prepared by or under the supervision of door supplier, using same reference numbers for openings as those on Drawings. Coordinate with door hardware schedule. Coordinate and indicate glazing of frames with glass requirements.

1.4 Quality Assurance

A. Obtain metal doors and frames from single source from single manufacturer.

B. Steel doors and frames, and their installation, shall conform to the following requirements of the Steel Door Institute:

1. ANSI A250.8, “Recommended Specifications for Standard Steel Doors and Frames” (formerly SDI 100).
2. ANSI A250.6, “Hardware on Standard Steel Doors.”
3. ANSI A250.11, “Recommended Erection Instructions for Steel Frames.”

C. Provide 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 according to NFPA 252, UL 10B and UL 10C.

1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450°F above ambient after 30 minutes of standard fire-test exposure.
2. Comply with CBC Chapter 7.
3. Provide steel doors which are identical in materials and construction to units tested in door and frame assemblies in accordance with ASTM E 152 and which are physically labeled and listed for ratings indicated by UL, Warnock Hersey or other testing and inspection agency acceptable to authorities having jurisdiction. Label shall be applied by an authorized facility in accordance with the procedure set forth by an independent certification agency.

D. Provide fire rated window assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Label each individual glazed light.

E. Smoke-Control Door Assemblies: Comply with NFPA 105.

F. Before beginning actual work, install mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of steel frame and door installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:

   a. Finishes and finish substrates.
   b. Door frame.
   c. Door.
   d. Frame anchors and fasteners.
   e. Finishes.
   f. Hardware.
Steel Doors and Frames
08 11 13 - 3

1.5 Delivery, Storage, and Handling

A. Deliver hollow metal work palletized, wrapped, and crated to provide protection during transit and project-site storage. Do not use non-vented plastic. Provide additional protection to prevent damage to finish of factory-finished units. Inspect doors and frames upon delivery. Remove and replace damaged units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions. Inspect doors and frames upon delivery for damage. Minor damage may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect, otherwise remove and replace damaged items as directed.

C. Store hollow metal work off floor, under cover at project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity. Avoid the use of non-vented plastic or canvas shelters to prevent forming of pockets of humidity and causing rust. Provide minimum 1/4 inch space between each stacked door and frame to permit air circulation. Do not store frames laid flat. If packaging on door becomes wet, remove immediately and dry doors and frames thoroughly.

1.6 Project Conditions

A. Verify actual dimensions of openings by field measurements before fabrication.

B. Verify actual finished wall thickness and required frame throat dimension prior to fabrication.
1.7 Coordination

A. Coordinate installation of anchorages 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 with electrical and access control requirements for wiring, conduit and control hardware requirements. Furnish doors and frames complete with necessary wire conduit and accommodations to satisfy electrical and access control requirements.

C. Coordinate with Section 08 71 00 “Door Hardware.” Furnish doors and frames fully prepped, mortised, drilled and otherwise ready for complete hardware installation.

D. Coordinate with mechanical ventilation design requirements for door louver and door undercut requirements.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Amweld Building Products, LLC.
2. Ceco Door Products; an Assa Abloy Group company.
3. Steelcraft; an Ingersoll-Rand company.

2.2 Materials

A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum G60 metallic coating.

C. Interior Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

D. For anchors built into exterior walls and anchors in masonry walls, steel sheet complying with ASTM A 1008, hot-dip galvanized according to ASTM A 153.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.

F. Powder-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. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
I. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities, compounded for 15-mil dry film thickness per coat.

2.3 Standard Metal Doors

A. Provide doors in configurations indicated, not less than thickness indicated; fabricated with smooth surfaces, seamless type with 1-piece face panels, all parts welded and finished flush and smooth. Honeycomb or foamed-in-place insulation cores are not acceptable. Fill doors with mineral fiber insulation or equivalent fire retardant insulation to eliminate all metallic ring noise.

1. Design: Flush panel.
2. Core Construction:
   a. Fire Door Core: As required to provide fire-protection indicated and code required temperature-rise ratings.
   b. Exterior Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0° F x h x sq. ft. /Btu when tested according to ASTM C 1363. 20 gauge steel stiffeners 4-inches on center, fill cavities with fiberglass insulation.
   c. Interior Doors: Kraft paper honeycomb.
   d. Provide doors that meet STC ratings indicated. ASTM E 336.
   e. Reinforce face panels with internal welded steel stiffeners.

4. Top and Bottom Edges: Closed with 16 gage channels of same material as face sheets. Provide flush channel on top and inverted channel on bottom. Reinforce all edges.

B. Fabricate exterior doors from metallic coated steel sheet throughout. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless) 16 gage. Patch galvanized coating after fabrication and preparation for hardware. Assure compatibility between galvanizing repair paint and proposed finished coatings.

C. Fabricate interior doors from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless) 18 gage.

D. Fabricate hardware reinforcement according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Fabricate door with necessary provisions for electrification and access controls as required. Verify requirements with access control, fire alarm, security and electrical trades prior to fabrication.

G. Prepare all doors for hardware.
H. Size doors to accommodate all hardware including door bottoms and thresholds. Provide doors with clear undercut indicated for ventilation where indicated.

I. Provide applied label containing “S” designation in addition to UL time and temperature rating on hinge edge indicating door complies with required fire rating, temperature rise and STC requirements. Locate label so as not to interfere with function, operation, closing or sealing of door.

J. Provide core materials according to ANSI A250.8 for internal door construction as follows:
   1. Interior Doors: As follows.
      a. Resin-impregnated paper honeycomb, at non-fire rated doors.
      b. Rigid mineral fiber with internal sound deadener on inside of face sheets, at fire-rated doors.

K. Fabricate supports and anchors of not less than 18 gage sheet steel; galvanized where used with galvanized frames or at exterior, damp or wet locations.

L. Where items are to be built into exterior walls, hot-dip galvanize inserts, bolts and fasteners in compliance with ASTM A 153, Class C or D as applicable.

2.4 Metal Frames

A. Provide full-formed sheet steel frames for doors, transoms, sidelights, borrowed lights, fixed windows and other openings, of type and styles as shown on Drawings and schedules, with concealed fastenings, welded construction ANSI A250.8 or equivalent custom fabricated frames conforming to referenced NAAMM standards.

   1. Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
   2. Provide doors and frames that meet the rated assemblies indicated
   3. Provide doors and frames that meet STC ratings indicated. ASTM E 336.
   4. Provide frame with applied label containing “S” designation in addition to UL time temperature rating on inside face of jamb that will be hidden by closed door indicating that frame complies with required fire rating, temperature-rise and STC rating. Mount label on hinge side of jamb so label is concealed when door is closed and so not to interfere with proper function, operation and closing of door, frame, hardware and seals.
   5. Reinforce heads over 42-inches-wide with full length 12 gage channel.
   6. Provide 26 gage steel plaster guards at back of cutouts for hinges or mortised hardware for frames installed in masonry or plaster construction. Provide plaster guards at cement plaster (stucco) and mortar-set tile conditions.
   7. Infill interior hollow metal frames with rigid cellular polystyrene or polyurethane-foam-type thermal insulation.

B. Fabricate exterior frames from metallic coated steel sheet. Fabricate frames with full profile welded mitered corners, 14 gage. Patch galvanizing on all exterior frames after fabrication and preparation for hardware. Assure compatibility between galvanizing repair paint and proposed finish coatings.

C. Interior Frames: Fabricated from cold-rolled steel sheet.

   1. Fabricate frames with full profile welded mitered corners:
      a. 14 gage for fire-rated frames.
      b. 16 gage for non-rated interior frames.
2. Frames for Borrowed Lights: Same as adjacent door frame.
3. Fabricate frames fully welded with all welds ground smooth and flush.

D. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
   1. Hinge Reinforcements: 9 gage, full mortise.
   2. Closer Reinforcements: 9 gage.

E. Fabricate frames with necessary provisions for electrification and access controls as required. Verify requirements with access control, fire alarm, security and electrical trades prior to fabrication.

F. Prepare all frames for hardware.

2.5 Frame Anchors

A. Provide anchors in accordance with ANSI A250.8. Anchors at fire rated frames shall also conform to UL Standard 10B.

B. Jamb Anchors:
   1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 16 gage.
   2. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   3. Universal type anchor for existing stud walls 16 gage.
   4. Anchors at Door Frames in Concrete or Masonry: Frames erected after concrete and masonry.
      a. Floor Anchors: 12 gage angle welded to frame, full width of frame section, one each jamb.
      b. Jamb Anchors: 12 gage channel or Z welded to frame full width of frame section less wall finish thickness with tube sleeve welded to anchor and to flame stop, drilled and deep dimpled for anchor and flat head screw for completely concealed fastening.
      c. Head Anchors: Provide anchors same as for wall, located at center of head, for pairs of doors only.
      d. Grouting: Grout door frames solid after installation.

   5. Anchors at Door Frames in Concrete or Masonry: Frames erected before concrete or masonry.
      a. Jamb Anchors: 12 gage T-anchor, loose in frame, full width of frame engaging frame returns, T-leg equal to wall thickness less 2 inches of frame width whichever is less. T-leg shall be 6 inches long with 1/2 inch diameter hole for reinforcement bar dowel, 3 per jamb.
      b. Head Anchors: Provide T-anchor same as wall anchors, located at center of head, at pairs of doors only.
      c. Grouting: Grout frame as surrounding construction progresses.

C. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.
2.6 Hollow Metal Panels

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 Stops and Moldings

A. Moldings for Glazed Lights in Doors: Minimum 0.032-inch-thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8-inch-high unless otherwise indicated. Miter and weld at corners. Grind all welds smooth.

C. Loose Stops for Glazed Lights in Frames: Minimum 0.032-inch-thick, fabricated from same material as frames in which they are installed. Miter at corners. Drill and countersink for oval head screws, completely fit ready for removal and glazing at site.

D. Terminated Stops: Where indicated on schedule, terminate door stops 6 inches above finish floor with a 45-degree angle cut, and close open end of stop with fully welded steel filler plate. Grind all welds smooth and flush with frame.

2.8 Louvers

A. Provide louvers for doors, where indicated on schedule, that comply with SDI 111C, with blades or baffles formed of 0.020-inch-thick, cold-rolled steel sheet set into 0.032-inch-thick steel frame. Provide removable frames; provide insect screens on interior side of exterior door louvers.

2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other, any angle.
3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.

2.9 Hollow Metal Accessories

A. Mullions and Transom Bars: Join to adjacent members by welding, grind all welds smooth.

B. Ceiling Struts: Minimum ¼-inch-thick by 1-inch-wide steel.

2.10 Fabrication

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Fit and assemble units in manufacturer’s plant to greatest extent possible. To ensure proper assembly at project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom exterior of exterior doors to permit moisture to escape to the outside. Seal joints in top edges of doors against water penetration.
3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Fabricate frames as one piece. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Sidelight: 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 butt welding; grind, fill, dress, and make smooth, flush and invisible.
3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
6. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 12 inches from top and bottom of frame. Space anchors as follows:
      1) Three anchors per jamb from 60 to 90 inches high.
      2) Four anchors per jamb from 90 to 120 inches high.
      3) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
   b. Stud-Wall Type: Locate anchors not more than 12 inches from top and bottom of frame. Space anchors as follows:
      1) Four anchors per jamb from 60 to 90 inches high
      2) Five anchors per jamb from 90 to 96 inches high.
      3) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
      4) Two anchors per head.
   c. Post-installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches on center.

7. Except on frames to receive weather-stripping or smoke seals, 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.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Factory prepare hollow metal work to receive mortised hardware; including but not limited to cutouts, reinforcements, mortising, drilling, and tapping required for door hardware as specified in Section 08 71 00 “Door Hardware.”
1. Locate hardware, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive all mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate requirements for conduit, wiring, and boxes for electrical and access control connections with Division 16 Sections and access control requirements. Prepare doors and frames to include and accommodate conduit and wiring.
5. Provide doors and frames pre-wired as required for electrical locking and access control.

G. Stops and Moldings: Provide stops around glazed lights where indicated. Form corners of fixed stops with full profile welded mitered joints.

2. Multiple Glazed Lights: Provide fixed and removable stops so that each glazed light is capable of being removed independently. Locate removable stops on non-secure side.
3. Provide fixed stops on outside of exterior and on secure side of interior frames.
4. Coordinate width between fixed and removable stops with type of glazing and type of installation.

H. Coordinate fabrication of doors and frames with smoke and draft, temperature rise, fire rating and STC requirements as indicated and required by reference standards and applicable building codes. Provide for all supplementary gaskets, tapes, seals, hardware and related devices to provide a complete compliant assembly.

2.11 Finishes, General

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. Variations in appearance of abutting or adjacent frame pieces are not acceptable. Noticeable variations in the same frame 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.

D. Provide removable stops and exposed fasteners with finish matching appearance, including color and texture of frames.

2.12 Shop Prime – Field Paint

A. Galvanized Surfaces:

1. Hot-dip galvanized steel doors and frames, after fabrication. Comply with ASTM A 123. Fill all holes and grind flush prior to galvanizing.
2. Chemically clean all surfaces with solvent complying with VOC regulations.
3. Wash all surfaces with etching solution such as Jasco Prep and Prime. Thoroughly rinse and dry surface.
4. Shop spray-apply an acid etch type primer to a dry film thickness recommended in writing by primer manufacturer. Apply primer within 3 hours of etching solution.
5. Stripe prime corners, crevices, bolts, welds and sharp edges.
6. After erection clean abraded areas and repair with galvanizing repair paint.

B. Ferrous Metal Surfaces:
1. Prepare uncoated ferrous metal surfaces to comply with SSPC 6/NACE No. 3 “Commercial Blast Cleaning.”
2. Shop spray-apply Zinc Rich Primer to all prepared surfaces, in compliance with SSPC-PA 1 “Paint Application Specification No. 1.” Primer need not be applied to surfaces embedded in concrete or masonry. Primer must extend past interface point of embedment.
3. Stripe prime corners, crevices, bolts, welds and sharp edges.
4. After erection sand and smooth damaged areas of primer coat and spray-apply identical primer.

C. Apply finish paint coats in field with sprayer only, refer to Section 09 90 00 for finish coat requirements.

D. Color and finish as selected by Architect from manufacturer’s full range.

2.13 Shop Prime – Shop Paint

A. Galvanized Surfaces:
   1. Hot-dip galvanized steel doors and frames, after fabrication. Comply with ASTM A 123. Fill all holes and grind flush prior to galvanizing.
   2. Chemically clean all surfaces with etching solution such as Jasco Prep and Prime. Thoroughly rinse and dry surface.
   3. Shop spray-apply an acid etch type primer recommended in writing by baked enamel finish coat manufacturer, to a dry film thickness recommended in writing by primer manufacturer. Apply primer within 3 hours of etching solution.
   4. Stripe prime corners, crevices, bolts, welds and sharp edges.

B. Ferrous Metal Surfaces:
   1. Prepare uncoated ferrous metal surfaces to comply with SSPC 6/NACE No. 3 “Commercial Blast Cleaning.”
   2. Shop spray-apply acid etch type primer recommended by baked enamel manufacturer to all prepared surfaces, in compliance with SSPC-PA 1 “Paint Application Specification No. 1.” Primer need not be applied to surfaces embedded in concrete or masonry. Primer must extend past interface point of embedment. Apply primer within 3 hours of blast cleaning.
   3. Stripe prime corners, crevices, bolts, welds and sharp edges.

C. Baked-Enamel Finish: AA-C12C42R1X. Apply baked enamel complying with paint manufacturer’s specifications, thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 603.8, except with a minimum dry film thickness of 1.5 mils.

D. Color and finish 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 for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, 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. Proceeding with installation of doors and frames constitutes acceptance of substrate conditions by contractor.

3.2 Preparation

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness 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 on a perpendicular line from head to floor.

3.3 Installation

A. Install metal doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions. Comply with ANSI/SDI A250.11, and ANSI A115.16. Fasten frames to structure to retain their position and stability.

B. For fire rated doors and frames installation comply with NFPA 80 and CBC Chapter 7.

C. Metal Frames: Install metal frames of size and profile indicated.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint. Use wood spreaders at bottom of frame if the shipping spreader is removed. Protect frame from accidental abuse. Where construction will permit concealment, leave the shipping spreaders in place after installation otherwise remove the spreaders after the frames are set and anchored. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

   a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   b. Install frames with removable glazing stops located on secure side of opening.
   c. Install door silencers in frames before grouting.
   d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   f. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
   g. Coordinate with installation of all conduit and wire for door control and power.

2. Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

4. Masonry Walls: Coordinate installation of frames with masonry construction and solid fill space between frames and masonry with grout. Where grouting is required, frames shall be braced and fastened in place to prevent the pressure of the grout from deforming the frame members. Mix grout to provide a 4 inch maximum slump consistency, hand troweled into place. Grout mixed to a thin “pumpable” consistency shall not be used. Anchors in masonry walls shall be embedded in mortar.

5. Cast-in-Place Concrete Walls: Cast concrete with frame secured in form work.

6. In-Place or Existing Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. In-Place or Existing Gypsum Board Partitions: Secure frames in place with post-installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces. Pack interior and exterior frames with mineral fiber insulation.

8. Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
   e. Doors shall be installed and fastened to maintain alignment with frames to achieve maximum operational effectiveness and appearance.

D. Fit hollow metal doors accurately in frames, within clearances specified below. Shimming shall be performed by the installer as needed to assure the proper clearances are achieved.

1. Non-Fire-Rated Standard Steel Doors:
   a. Jambs and Head: 1/8 inch plus or minus 1/32 inch.
   b. Between Meeting Edges of Pairs of Doors Non-Fire Rated: 3/16 inch plus or minus 1/16 inch; fire rated 1/8 inch plus or minus 1/16 inch.
   c. Between Bottom of Door and Top of Threshold: Maximum 1/4 to 1/2 inch unless otherwise required for specified door bottom.
   d. Between Bottom of Door and Top of Floor Finish (No Threshold): Maximum 3/4 inch. Verify finish and transition materials prior to fabrication.
   e. Between Face of Door and Door Stop: 1/16 inch and 1/8 inch plus or minus 1/32 inch without stops, silencers and seals.

2. Install fire-rated doors with clearances according to NFPA 80.

3. Install smoke-control doors according to NFPA 105.

E. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow metal manufacturer’s written instructions. Secure removable stops with countersunk flat-head machine screws spaced uniformly not more than 9 inches on center and not more than 2 inches on center from each corner. Finish head of screw to match finish of stop.
F. Installation of hardware items shall be in accordance with the hardware manufacturer’s recommendations and templates. ANSI A115.IG, “Installation Guide for Doors and Hardware” shall be consulted for other pertinent information. Comply with requirements of Section 08 71 00.

3.4 Adjusting and Cleaning

A. Metal Repairs:

1. Make repairs only if permitted by Architect. Otherwise, replace damaged components.
2. Fill surface depressions with metallic paste filler, allow to thoroughly cure, sand flush, and smooth for an invisible appearance with adjacent metal surfaces.
3. Sand smooth all corroded areas.
4. Apply touch up paint using air drying primer compatible with shop applied finish.

B. Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air drying primer.

C. Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

D. Remove grout and other bonding material from hollow metal work immediately after installation.

E. Adjust all doors and hardware after building HVAC system has been turned on and balanced and test reports have been submitted to and accepted by Owner.

F. Adjust doors to accommodate thermal movement and expansion of frame and door.

G. Provide additional adjustment as required by Architect to assure all doors function properly at no additional cost or time to Owner.

H. Immediately prior to final inspection, remove protective covering from prefinished doors. Clean doors and frames of surface contaminants detrimental to bonding of field applied finishes.

END OF SECTION 08 11 13
SECTION 08 12 16 - Interior Aluminum Doors and Frames

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section includes:
   1. Pre-finished aluminum door frames for interior use.
   2. Pre-finished sound control aluminum door frames for interior use.
   3. Pre-finished aluminum window frames for interior use.
   4. Pre-finished aluminum framing systems for interior use.
   5. Pre-finished aluminum doors for interior use.

B. Related Sections include the following:

   1. Section 05 40 00 “Cold-Formed Metal Framing.”
   2. Section 07 92 00 “Sealants.”
   3. Section 08 71 00 “Door Hardware.”
   4. Section 08 80 00 “Glazing.”
   5. Section 09 22 16 “Non-Structural Metal Framing.”
   6. Section 09 23 00 “Gypsum Board.”
   7. Section 09 30 00 “Tile.”
   8. Section 09 90 00 “Painting.”
   9. Section 10 14 00 “Signage.”
   10. Division 26 Electrical Sections.
   11. Division 27 Communications Sections.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction

   1. AAMA 603.8 - Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
   7. ASTM E 413 – Classification of Sound Rating Insulation.
   8. NAAMM - "Metal Finishes Manual for Architectural and Metal Products'.
1.3 **Submittals**

A. Submit under the provisions of Section 01 30 00.

B. **Product Data:** For each type of product indicated. Include construction details, material descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

C. **Templates:** Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the interior aluminum door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

D. **Shop Drawings:** Include the following:
   1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   2. Locations of reinforcement and preparations for hardware.
   3. Details of each different wall opening condition. Include requirements for steel framing at partitions for fit and securing of frames, partition widths and tolerances, direction of framing members, clips and attachments.
   4. Details of anchorages, joints, field splices, and connections.
   5. Details of accessories.
   6. Details of moldings, removable stops, and glazing.
   7. Elevations of each door design.
   8. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   9. Details of preparations for power, signal, and control systems.

E. **Samples for Verification:** Provide at the request of architect, prepared Samples as indicated below:
   1. Framing Member: 12 inches long.
   2. Corner Fabrication: 12-by-12-inch-long, full-size window corner, including full-size sections of extrusions with factory-applied color finish.
   3. Aluminum chips in full range manufacturer’s standard finishes for architect’s color selection.

F. **Interior Aluminum Door and Frame Schedule:** Use same designations indicated on Drawings. Coordinate with Door Hardware schedule and glazing.

1.4 **Quality Assurance**

A. **Source Limitations:** Obtain interior aluminum frames and doors through one source from a single qualified manufacturer.

B. **Manufacturer Qualifications:** A firm experienced in the manufacturing of interior aluminum framing systems and doors with a minimum five (5) years successful in-service performance providing product similar to those indicated for this project, including pre-engineering and prefabricating all components of aluminum framing systems and doors.

C. **Installer Qualifications:** An experienced installer with a minimum five years (5) experience who has completed aluminum framing systems and door installations similar in material, design, and extent to those indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

D. **Aesthetic Effects:** Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect’s approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
E. Pre-Installation Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing interior aluminum frames and doors and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 Delivery, Storage and Handling

A. Deliver interior aluminum frames and doors individually protective wrapped within cartons and marked for the corresponding scheduled opening. Do not bulk pack frames.

B. Inspect frames upon delivery for damage.

1. Repair minor damage to pre-finished products as recommended by manufacturer.
2. Replace frames that cannot be satisfactorily repaired.

C. Store interior aluminum frames and doors at Project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.6 Project Conditions

A. Field Measurements: Verify actual dimensions of interior aluminum frame openings by field measurements before fabrication and indicate measurements on Shop Drawings submittals.

B. Do not install aluminum frames and doors until area of work has been completely enclosed and interior is protected from the elements.

C. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy standards. If necessary, provide artificial heating, cooling and ventilation to maintain required environmental conditions.

1.7 Warranty

A. Provide manufacturer's written warranty against defects in materials and workmanship upon final completion and acceptance of Work in this section.

1. Warrant framing and door finishes against defects and excessive fading and nonuniformity in color for a period of 5 years.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Frameworks Manufacturing.
2. Custom Components Company.
3. Versatrac Frames, a Division of American Door Products Inc.
4. Western Integrated Materials, Inc.

B. Substitutions: Material from alternate interior aluminum framing system and door fabricators will not be accepted on jobsite without prior written and sample approval in accordance with requirements specified in Division 01 and at the discretion of Architect and their designated openings consultant.

2.2 Materials
A. Extruded Aluminum: ASTM B 221 alloy 6063-T5 or alloy and temper required to suit structural and finish requirements.

B. Recycled Content of Aluminum Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

C. Interior Aluminum Frames:

1. Provide interior aluminum framing components complying with dimensions, profiles, and relationships to adjoining work of components as indicated on Drawings. Provide frames that are adjustable for partition types and throat openings, or that are fitted to each partition type, meeting the throat opening and required clearances per frame manufacturer's recommendations. Reinforce for specified hinges, strikes, and closers.
2. Type I Framing System: Provide frames with the following characteristics:
   a. Rectilinear design.
   b. 1-1/2 inch face profile, 9/32 inch return.
   c. .062 inch rabbet wall thickness.
   d. Throat sizes (drywall partition thickness): 3-3/4", 4-7/8".
3. Type II Framing System: Provide frames with the following characteristics:
   a. Rectilinear design.
   b. 1-1/2 inch face profile.
   c. Snap on trim:
      1) 1-1/4 inch.
      2) 1-1/2 inch.
      3) 2 inch.
   d. .062 inch rabbet wall thickness.
   f. Adjustable throat frames expandable from 2-7/8" up to 8-3/8".
4. Glass Trim: Extruded aluminum, not less than 0.062 inch thick, designed for glass thickness indicated with removable snap-in casing trim, glazing stops, and door stops without exposed fasteners.

D. Interior Aluminum Doors:

1. General: Provide 1-3/4 inch doors of type and design indicated, not less than 0.062 inch thick material.
2. Aluminum Stile & Rail Type Swinging Doors: Door stiles and rails to have tubular design with the following characteristics:
   a. Stiles:
      1) Wide Stile (5").
   b. Rails:
      1) 6" Top/Bottom Rail.
      2) 9-1/2" Bottom Rail.
3. Snap-in stops with factory applied glazing gaskets for 1/4" thick glass.

E. Aluminum Stile & Rail Sliding Type Doors: Subject to the same tubular design standards as Stile & Rail Type Swinging Doors with the following characteristics:

1. Sliding door track to be installed in properly blocked ceiling or wall above frame, or to header clip (by manufacturer) attached to the frame header. Sliding track to be provided with snap on covers.
2. Sliding Door Hardware:

   a. Tricycle Rollers: 2 each per panel. Maximum 1 each roller per 75 lbs.
   b. Provide bumper stops in track assemblies.
   c. Provide concealed door guide at floor (track assemblies are not allowed).

2.3 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.

C. Glazing Gaskets: Manufacturer's standard extruded or molded plastic, to accommodate glazing thickness indicated.

D. Glazing: Comply with requirements in Division 08 Section, "Glazing."

E. Hardware: As specified in Division 08 Section, "Door Hardware".

2.4 Fabrication

A. Frame Construction:

1. Factory pre-engineer and pre-cut interior aluminum frame components to the greatest extent practical. Linear glazing components fabricated in the field are not allowed. Allow for 2 inches excess vertical length for scribing to suit floor conditions. Face trim to be pre-cut to match jamb lengths. Machine jambs and prepare for hardware, with concealed plates, drilled and tapped as required, fastened in frame with concealed screws.

2. Provide concealed corner reinforcements and alignment clips for precise joints at butt or mitered connections.

3. Hardware Preparation: Factory interior aluminum frames to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates as specified in Division 08 Section, "Door Hardware."

   a. Reinforce frames to receive surface mounted door hardware. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within frame with concealed screws.
   b. Locate hardware as indicated.
   c. Coordinate locations of conduit, wiring boxes, and power transfers for electrical connections with Division 26 Sections.

4. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.

5. Fabricate all components to allow secure installation without exposed fasteners.

B. Door Construction:
1. Factory pre-engineer aluminum doors and components to the greatest extent practical.
2. Hardware Preparation: Factory interior aluminum doors to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates as specified in Division 08 Section, “Door Hardware.”
   a. Reinforce doors to receive surface mounted door hardware. Machine and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within door with concealed screws.
   b. Locate hardware as indicated.
   c. Coordinate locations of conduit and power transfers for electrical connections with Division 26 Sections.
3. Clearances for Non-Fire-Rated Door Frames: Not more than 1/8 inch at jambs and heads, not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
4. Fabricate kits for glazing with removable stops to allow glazing replacement without dismantling.

2.5 Aluminum Finishes

A. General: Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products' for recommendations for apply and designated finishes. Exposed surfaces to be free of scratches and other serious blemishes.

B. Factory finish extruded frame components so that any part exposed to view upon completion of installation will be uniform in finish and color.

C. Polyester Finish: Comply with AAMA 603.8; multiple-stage electrostatically applied thermoset polyester finish, baked to assure hardness.
   1. Color: Custom paint color to match architect sample.
   2. Color: Manufacturer’s standard bronze.
   3. Color: Manufacturer’s standard gray.
   4. Color: Manufacturer’s standard black.
   5. Color: Manufacturer’s standard white.

D. Clear anodic coating: Comply with AAMA 607.1.
   1. Class 2, AAM12C22A31 clear anodized coating, 0.4-.07 mill thickness minimum.

E. Color anodic coating: Comply with AAMA 608.1.
   1. Class 2, AAM12C22A34 color coating electrolytically deposited, 0.4-0.7 mill thickness minimum.
      b. Color: Black anodized.
   2. Class 2, AAM12C22A44 color coating electrolytically deposited, 0.4-0.7 mill thickness minimum.
      b. Color: Black anodized.

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 wall thickness does not exceed standard tolerances allowed by specified frame throat sizes.

C. General Contractor to verify the accuracy of dimensions given to frame and door manufacturer for pre-cut openings.

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

3.2 Installation

A. General: Install and set interior aluminum frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

1. At fire-protection-rated openings, install frames according to NFPA 80.

B. Install frame components in the longest possible lengths with no component less than 48 inches.

1. Fasten to suspended ceiling grid at 48 inches on center maximum, using #6 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 use screws or other fasteners exposed to view when installation is complete.

3.3 Adjusting and Cleaning

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition.

B. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AMMA 609 & 610.

C. Touch up marred areas so that touch up is not visible from a distance of 48 inches. Remove and replace frames that cannot be satisfactorily repaired.

3.4 Protection

A. Provide protection as required to assure that frames will be without damage or deterioration upon substantial completion of the project.

END OF SECTION 08 12 16
SECTION 08 71 00 - Door Hardware

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 08 11 13 “Steel Doors and Frames.”
2. Section 09 90 00 “Painting.”
3. Section 10 28 16 “Toilet and Bath Accessories.”
4. Section 12 35 50 “Institutional Casework.”
5. Division 26 Electrical Sections.

1.2 References

A. Use date of standard in effect as of bid date:

4. BHMA – Builders Hardware Manufacturers Association.
5. DHI – Door and Hardware Institute – Recommended Locations for Builder’s Hardware for Standard Steel Doors and Frames.
6. NFPA – National Fire Protection Association:
   b. NFPA 105 – Smoke and Draft Control Door Assemblies.
7. UL – Underwriters Laboratories:
   a. UL 10C – Positive Pressure Fire Tests of Door Assemblies.
   b. UL 305 – Panic Hardware.
9. Local applicable codes.
10. SDI – Steel Door Institute.
11. WI – Woodwork Institute.
12. AWI – Architectural Woodwork Institute

1.3 Submittals

A. Door Hardware Sets: Prepared by installer and a certified Architectural Hardware Consultant (AHC). Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware. Indicate complete designations at every item for each door.
1. Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page. Only submittals that are 8-1/2 x 11 one-sided will be accepted and reviewed. Organize vertically formatted schedule with door designation headings and complete designation of every item required for each door opening.

2. Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

3. Content: Include the following information:
   a. Identification number, location, hand, fire rating and material of each door and frame.
   b. Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device. Use BHMA finish codes per ANSI A156.18.
   c. Provide complete designations of every item required for each door or opening including name, part number and manufacturer.
   d. Fastenings and other pertinent information.
   e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   f. Explanation of abbreviations, symbols, and codes contained in schedule.
   g. Door and frame sizes and materials.
   h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems. Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
   i. Explanation and legend for all abbreviations.
   j. Graphic illustration(s) showing mounting locations and dimensions for all hardware items.
   k. Provide keying schedule prepared by installer and hardware expert, detailing Owner’s final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.
   l. Indicate hardware mounting locations.

4. Submit door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in project construction schedule. Coordinate with all work to determine critical path timing. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

B. Product Data: Manufacturer’s catalog cuts showing construction and installation details, material descriptions, functions, dimensions of individual components and profiles, and finishes. Indicate mounting heights for each type of hardware.

C. Shop Drawings: Details of electrified door hardware, indicating the following:
   1. Wiring Diagrams: Power, signal, and control wiring diagrams. Include the following:
      a. System schematic.
      b. Point-to-point wiring diagram.
      c. Riser diagram.
      d. Elevation of each door.
   2. Detail interface between electrified door hardware and fire alarm, access control and security system.
   3. Describe the operation of doors controlled by electrified door hardware.
4. Submittals prepared without thorough jobsite visit by qualified hardware expert will be rejected as non-compliant. Submit written statement from hardware expert indicating that Jobsite visit has been completed.

D. Finish Samples: Submit minimum 2-by-4-inch plate samples of each type of finish required, except primed finish.

E. Hardware Samples: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets. 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.

F. Provide letter on installer’s letterhead certifying that door hardware supplied for use on types and sizes of labeled fire doors comply with listed fire door assemblies.

G. Provide keying schedule prepared by installer and Architectural Hardware Consultant (AHC), detailing Owner’s final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1. After completion of door hardware schedule review and prior to ordering hardware, schedule and conduct a keying meeting to determine keying requirements and develop a keying schedule.
2. Meeting shall be between AHC employed by hardware supplier, Owner’s representative, Architect and other involved parties to ensure that locksets are functionally correct and that keying fulfills project requirements.
3. Prepare and submit keying schedule for record purposes only. Include in keying schedule all doors with locks, all padlocks and all lock cylinders using building keying system.

1.4 Quality Assurance

A. Provide installer/supplier who is a direct factory contract supplier and employer of workers trained and approved by lock manufacturer, with a minimum 5 years experience specializing in providing institutional hardware.

1. Installer/supplier responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant (AHC) available during the course of the work to consult with contractor, Architect, and Owner about door hardware and keying.
2. Installer/supplier shall have warehousing facilities in project’s vicinity.
3. Responsible for preparation of door hardware and keying schedules.
4. Responsible for 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.
5. Installer / supplier shall be or shall employ a certified Architectural Hardware Consultant (AHC) certified by the Door and Hardware Institute (DHI) to prepare the door hardware schedule utilizing products specified in this Section and complying with applicable Code requirements and requirements of the manufacturers.

B. Obtain each type of door hardware from a single manufacturer, unless otherwise indicated. 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.

C. Provide fire-rated door assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing
according to NFPA 252. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

D. Provide electrified door hardware listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Before beginning actual installation, install mockups for each typical type of door frame and hardware to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:

   a. Door finishes.
   b. Frame – finished and with boxes and backing plates.
   c. Wall finish and trim.
   d. All hardware seals and trim.
   e. Sealant joints.
   f. Sheathing, framing and substrates.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

F. Conduct pre-installation meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Include supplier, manufacturer’s representative, installer, and Owner. Discuss installation techniques, sequence of installation and interface with other trades. Adjust installation strategy to meet all project requirements at no additional cost or time to Owner.

G. If discrepancy between drawings and scheduled material in this section is discovered during bidding or should have been known by contractor, provide written RFI to Architect and provide for the more expensive of the two choices, at no additional cost to Owner. Note the discrepancy in submittals. When determining the more expensive option consider all aspects of the work including but not limited to supervision, delivery time, sequencing installation, coordination with other trades, submittal processing time, overhead consideration and all other aspects affecting cost of installing option provided.

H. Provide hardware free of defects, blemishes and excessive play. Obtain each type of hardware and associated devices from one manufacturer.

I. Exit doors shall be operable from inside with single motion without the use of a key or special knowledge or effort.
J. Furnish hardware items and materials required for a complete functional installation in accordance with specified performance level and design intent, complying with manufacturers’ written instructions.

K. Where scheduled hardware items are obsolete, bid and provide manufacturer’s updated item at no additional cost to Owner. Coordinate requirements of updated items with door and frame fabrication.

L. Providing undocumented, false and fraudulent imitations of specified hardware items will not be acceptable and all such items must be removed from the site. Such items will not be paid for by Owner. All hardware items must be originally produced by specified manufacturer or approved equal, with full documentation, part, make and model numbers and packaged in manufacturer’s original unopened, labeled containers and packaging, and provided with manufacturer’s warranties.

M. Furnish all items of hardware even if not specifically identified or indicated to provide complete installation in accordance with the Contract Documents and the manufacturer’s written requirements. All hardware items shall be of equal quality and type.

N. Where the hardware items specified are not adaptable to the finished shape or size of the door and framing members requiring hardware, submit for Architect’s written approval, suitable alternative types having as nearly as practicable the same operation and quality as the type specified.

O. The use of one manufacturer’s numeric designation system in schedule does not imply that another manufacturer’s products will not be acceptable, unless they are not equal in design, size, weight, finish, function, or other quality of significance.

P. Provide hardware for fire-rated openings in compliance with NFPA 80. This requirement takes precedence over other requirements for such hardware. Provide only such hardware that has been tested and listed by UL for the type and size of each door required, and complies with the requirements of the door and door frame. Latching hardware, door closers, ball bearing hinges, and seals are required whether listed in the hardware schedule or not. Confirm hardware provided conforms to fire testes assembly ratings indicated.

1. Where panic exit devices are required on fire-rated doors, provide supplementary marking on door UL label indicating “Fire Door to be Equipped with Fire Exit Hardware” and provide UL label on exit device indicating “Fire Exit Hardware.”

   a. Provide a readable, durable sign on or adjacent to door stating, “This Door to Remain Unlocked Whenever the Building is Occupied.”

      1) Sign letters shall not be less than one inch high on contrasting background.

2. Install hardware for smoke-control door assemblies in accordance with NFPA 105.
3. Hinges at fire rated assemblies: Steel base material only.
4. Closers: Bolted (not screwed) to door reinforcement or through-bolted with sex-nut fasteners.
5. Latchbolts: 3/4 inch minimum throw or as required for fire rated assembly label.

Q. Provide door hardware on building perimeter doors with constructions cores and keying, to secure the project at the earliest date possible after close-in of the building. Provide permanent cores and keying to Owner. Replace construction cores with permanent cores just prior to Substantial Completion.

1.5 Delivery, Storage, and Handling

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to project site.
B. Tag each item and package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers. Package hardware items into sets by doors. Maintain factory shipping cartons and packaging where feasible.

C. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

D. Provide securely locked storage area for hardware to protect from theft, moisture, sunlight, paint, chemicals, dust, excessive heat and cold.

1.6 Coordination

A. Provide templates and coordinate layout and installation of recessed hardware items with floor construction. Cast anchoring inserts into concrete. Coordinate with concrete, reinforcement, and formwork prior to placement of each to assure proper placement and function of hardware. Coordinate backing and blocking requirements in stud framed walls prior to framing being enclosed. Verify that blocking and backing are securely fastened, adequately located, and is of sufficient quantity.

B. Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with requirements.

C. Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system. Provide hardware as necessary to accommodate wiring. Coordinate security card readers and security door contacts with Owner’s representative. Refer to door schedule and electrical drawings for doors requiring security hardware. Provide installation and technical data for security and access control hardware to other related Sections. Upon completion of electronic security and access control hardware installation, verify that all components are working properly, and state in the required guarantee that this inspection has been performed.

D. Where new 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 for proper operation.

E. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for a complete and proper installation and function. Furnish trades with the following information:

1. Location of embedded and attached items to concrete.
2. Location of wall-mounted hardware, including wall stops.
3. Location of finish floor materials and floor-mounted hardware.
4. Locations for conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety alarm and access control system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
5. Manufacturer templates to door and frame fabricators.

F. Coordinate with glass and framed entrances to confirm that adequate provisions will be made for proper hardware installation. Do not order hardware until coordination with frame and door suppliers for compatibility with their products. Coordinate with glass and framed entrances suppliers to determine extent of hardware being provided for entrances. Review storefront and entrances submittals to confirm that adequate provisions are being made for proper hardware installation.
G. Prior to submittal, carefully inspect actual conditions at each opening to verify finish hardware required to complete work, including sizes, quantities, existing hardware schedule for re-use, and sill condition material. If conflict or incompatibility between the specified/scheduled hardware and actual conditions, submit request for direction from Architect. Include date of jobsite visit in the submittal.

H. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Architect’s approval.

I. Coordinate hardware requirements with concrete work. Provide templates and inserts to concrete trades for inclusion in form work.

J. Reinforce walls for wall-mounted hardware, including wall stops and stainless steel guard rails.

K. Coordinate finish floor materials and floor-mounted hardware.

L. Furnish manufacturer templates to door and frame fabricators.

1. Ensure proper blocking in wood doors to support wood screws for panic hardware and door closers.
2. Ensure proper reinforcement in metal doors and frames to support machine screws for panic hardware and door closers.

1.7 Warranty

A. Contractor and installer/supplier jointly agree 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 operators and door hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:
   a. Locksets: Five years.
   b. Exit Devices: Three years mechanical, one year electrical.
   c. Closers: Ten years mechanical, two years electrical.
   d. Hinges: Life of building.
   e. Other Hardware: Two years.

1.8 Maintenance Service

A. Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware. Tools shall be as supplied or recommended by door hardware manufacturer.

B. Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.
1. Check and readjust every item of hardware.
2. Consult with and instruct Owner’s personnel in recommended additions to maintenance procedures.
3. Replace hardware items which have deteriorated or failed due to other than misuse or abuse.
4. Prepare a written report of current and predictable problems of substantial nature in the performance of door hardware.

1.9 Extra Materials

A. Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Door Hardware: 1%.
   2. Electrical Parts: 1%.

1.10 Commissioning

A. Conduct these tests prior to request for certificate of Substantial Completion:
   1. With installer present, test all door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
   2. With installer, access control contractor and electrical contractor present, test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
   3. With installer and electrical contractor present, test hardware interfaced with fire/life-safety system for proper operation and release.

1.11 Regulatory Requirements

A. Doors and doorways that are part of an accessible route shall comply with CBC Section 11B-404.
B. The clear opening width for a door shall be 32-inches minimum. For a swinging door it shall be measured between the face of the door and the stop, with the door open 90 degrees. There shall be no projections into it below 34-inches and 4-inches maximum projections into it between 34-inches and 80-inches above the finish floor or ground. Door closers and stops shall be permitted to be 78-inches minimum above the finish floor or ground. CBC Section 11B-404.2.3.
C. Handles, pulls, latches, locks and other operable parts on accessible doors shall comply with CBC Section 11B-309.4 and shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. Operable parts of such hardware shall be 34-inches minimum and 44-inches maximum above finish floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides. CBC Section 11B-404.2.7.
D. The force for pushing or pulling open a door shall be as follows: CBC Section 11B-404.2.9.
   1. Interior hinged doors, sliding or folding doors, and exterior hinged doors: 5 pounds maximum.
   2. Required fire doors: The minimum opening force allowable by the DSA authority, not to exceed 15 pounds.
   3. These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position.
   4. The force required to activate any operable parts, such as retracting latch bolts or disengaging other devices, shall be 5 pounds maximum to comply with CBC Section 11B-309.4.
E. Door closing speed shall be as follows: CBC Section 11B-404.2.8.
1. Closer shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds minimum.

2. Spring hinges shall be adjusted so that the required time to move a door from an open position of 70 degrees to the closed position is 1.5 seconds minimum.

F. Thresholds shall comply with CBC Section 11B-404.2.5.

G. Floor stops shall not be located in the path of travel and 4-inches maximum from walls. DSA Policy 99-08.

H. Hardware (including panic hardware) shall not be provided with “Night Latch” (NL) function for any accessible doors or gates unless the following conditions are met per DSA Interpretation 10-08 DSA/AC (External), revised 4/28/09. Such conditions must be clearly demonstrated and indicated in the specifications:

1. Such hardware has a “dogging” feature.
2. It is dogged during the time the facility is open.
3. Such dogging operation is performed only by employees as their job function (non-public use.)

I. Pair of doors: Limit swing of one leaf to 90 degrees so that a clear floor space is provided beyond the arc of the swing for the wall-mounted tactile sign. CBC Section 11B-703.4.2.1.

J. Provide UL labels on all exiting devices in fire-rated openings.

K. Provide permanent labels on all hardware required to achieve specified ratings on fire rated doors, indicating the listing agency and conditions of the listing.

L. Exit doors shall be openable at all times from the inside without use of key or special knowledge or effort.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following. Unless specifically indicated otherwise due to campus standards, manufacturers and products indicated are intended to determine quality and performance level only.

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<tr>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>ABBREVIATION</th>
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<tr>
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<td>Continuous Hinges</td>
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Closers | LCN Closers | LCN
Auto Flush Bolts | H.B. Ives | IVE
Coordinators | H.B. Ives | IVE
Silencers | H.B. Ives | IVE
Push & Pull Plates | H.B. Ives | IVE
Kickplates | H.B. Ives | IVE
Stops & Holders | H.B. Ives | IVE
Overhead Stops | Glynn-Johnson Hardware | GLY
Thresholds | Pemko | PMK
Seals & Bottoms | Pemko | PMK
Key Cabinets | Lund | LUN
Aluminum Door Locks | Adams Rite | ADA
Signs | Specialized Builders Hardware | SBH

2.2 Door Hardware, General

A. Provide door hardware as scheduled in DOOR HARDWARE SCHEDULE herein.

B. Do not use products which have manufacturer’s name or trade name displayed in a visible location.

1. Exception: Required fire labels.
2. Exception: As directed by or acceptable to the Architect.
3. Exception: Manufacturer’s identification on rim of lock cylinders.

C. Catalog numbers are indicated in the DOOR HARDWARE SCHEDULE to establish operation, function, quality, weight, size, pattern, design, material, and finish required.

D. Provide hardware manufactured to conform to published templates.

E. All hardware applied to metal doors or jambs shall be made to template and secured by machine screws. Furnish templates to the metal door and frame manufacturer for application at the factory, unless otherwise requested.

F. Provide all hardware necessary to complete work. Products not specifically identified but necessary shall be provided of type and quality generally recognized in door hardware industry for service duty of project type, location and usage, as selected by contractor and subject to acceptance by Owner and Architect.
G. Should specified hardware conflict with configuration of doors, frames and surrounding construction, provide comparable alternative hardware which maintains intended function of door, as selected by contractor and subject to review and acceptance by Owner’s Representative and Architect.

2.3 Hinging Methods

A. Drawings typically depict doors at 90 degrees; doors shall swing to maximum allowable. Use wide-throw hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180 degree opening. Advise Architect with written RFI if 8-inch width is insufficient. Include most expensive requirement at no additional cost to Owner.

B. Where manufacturer’s standard exceeds the scheduled product, furnish the more expensive of the two choices, at no additional cost to Owner. Notify Architect with written RFI of deviation from scheduled hardware.

C. Conventional Hinges: Stainless steel pins and concealed bearings. Hinge open widths of sufficient throw to permit maximum door swing, minimum.

2. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
3. Furnish 3 hinges per leaf for doors 7 foot high. Add 1 additional hinge for each additional 30 inches of door height or fraction thereof.
4. Provide full-mortise, 5-knuckle design, templated. See DOOR HARDWARE SCHEDULE for specific products. Provide shims and shimming instructions for proper door adjustment.
   a. Typical interior butt hinges: Standard weight, non-ferrous or steel base metal at not-rated doors and steel base metal at fire-rated doors, with steel pin and specified finish.
   b. Typical exterior butt hinges: Stainless steel, with stainless steel pin.

5. Provide ball bearing hinges at all doors with closers.
6. Provide butt hinge height and weight as scheduled. If not scheduled, or otherwise indicated, provide height and weight of butt hinges as follows:

<table>
<thead>
<tr>
<th>Door Thickness</th>
<th>Door Width</th>
<th>Hinge Height</th>
<th>Hinge Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3/4 inches</td>
<td>1 to 36-inches</td>
<td>4-1/2 inches</td>
<td>Standard</td>
</tr>
<tr>
<td>1-3/4 inches</td>
<td>37-inches to 42-inches</td>
<td>5-inches</td>
<td>Heavy</td>
</tr>
<tr>
<td>1/3/4 inches</td>
<td>Over 42-inches</td>
<td>5-inches</td>
<td>Extra Heavy</td>
</tr>
</tbody>
</table>

7. Unless otherwise specified, the width of butt hinges shall be sufficient to clear frame and trim projection when door swings 180 degrees.
8. Provide standard flat tips.

2.4 Locksets, Latchsets, Deadbolts

1. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C
2. Fit ANSI A115.1 door preparation
3. Functions and design as indicated in the hardware groups
4. 3/4-inch throw, anti-friction latchbolt made of self-lubricating stainless steel
5. Deadbolt functions shall have 1 inch throw bolt made of hardened stainless steel
6. Auxiliary deadlatch
7. Provide curved-lip strike with dust box for each latch or lock bolt, with lip extended to protect frame, finished to match door hardware set, unless otherwise indicated.
8. Lever handles must be of forged or cast brass, bronze or stainless steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable.
9. Lock shall have self-aligning, thru-bolted trim.
10. Levers to operate a roller bearing spindle hub mechanism.
11. Mortise cylinders of lock shall have a concealed internal setscrew for securing the cylinder to the lockset. The internal setscrew will be accessible only by removing the core, with the control key, from the cylinder body.
12. Spindle to be designed to prevent forced entry from attacking of lever.
13. Each lever to have independent spring mechanism controlling it.
14. Core face must be the same finish as the lockset.

### 2.5 Exit Devices / Panic Hardware

#### A. General Features:

1. Certified by BHMA for ANSI 156.3, Grade 1.
2. Tested and approved by BHMA for ANSI 156.3, Grade 1.
3. Provide a deadlocking latchbolt.
4. Non-fire rated exit devices shall have cylinder dogging for both mechanical and electric latch retraction type devices.
5. Touchpad shall be “T” style with no overlapping end caps to snag clothing.
6. Exposed components shall be of architectural metals and finishes.
7. Lever design shall match lockset lever design.
8. Provide strikes as required by application.
9. Fire exit devices to be listed for UL10C.
10. UL listed for Accident Hazard.

### 2.6 Closers

#### A. Surface Closers:

1. Certified by BHMA for ANSI 156.4, Grade 1.
2. UL10C listed.
3. Closer shall have extra-duty arms and knuckles.
5. Maximum 2 7/16 inch case projection with non-ferrous cover.
7. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions.
8. Full rack and pinion type closer with 1½“ minimum bore.
9. Mount closers on non-public side of door, unless otherwise noted in specification.
10. Closers shall be non-handed, non-sized and multi-sized.

### 2.7 Other Hardware

#### A. Automatic Flush Bolts: Low operating force design.

#### B. Overhead Stops: Non-plastic mechanisms and finished metal end caps. Field changeable hold-open, friction and stop-only functions.

#### C. Kick Plates: Four beveled edges, .050-inches-minimum thickness, 10 inches high by door width less 4 inches. Provide oval head machine or wood screws of material and finish to match kick plate. Flush screw heads with metal surface.
D. Door Stops: Provide stops to protect walls, casework or other hardware.

1. Unless otherwise noted in Hardware Sets, provide wall type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type. Coordinate location and assure backing in wall.

E. Seals: Finished to match adjacent frame color. Provide solid neoprene seal material. Do not furnish vinyl seal material. Provide UL rated seals on rated doors to comply with fire rated assembly requirements.

1. Non-corroding fasteners at in-swinging exterior doors.
2. Sound Control Openings: Use components tested as a system using nationally accepted standards by independent laboratories. Ensure that the door leafs have the necessary sealed-in-place STC ratings. Fasten applied seals over bead of sealant.
3. Fire-Rated Doors, Resilient Seals: UL 10C / UBC Standard 7-2 compliant. Coordinate with selected door manufacturers’ and selected frame manufacturers’ requirements. Where rigid housed resilient seals are scheduled in this section and the selected door manufacture only required an adhesive-mounted resilient seal, furnish rigid housed seal at minimum. Adhesive applied seals alone are deemed insufficient for this project where rigid housed seals are scheduled.

F. Thresholds: As per details.

1. Exteriors: Seal perimeter to exclude water and vermin. Provide sealant complying with requirements in Section 07 92 00 “Sealants.” Provide non-ferrous 1/4 inch Red-Head #SFS-1420. Flat Head Sleeve Anchors (SS/FHSL) or approved equal. Coordinate and provide threshold flashing per Section 07 62 00 “Sheet Metal Flashing and Trim.”
2. Fire-Rated Openings, 90 Minutes or Less Duration: Use thresholds to interrupt floor covering material under the door where that material has a critical radiant flux value less than 0.22 watts per square centimeter, per NFPA 253.
3. Fire-Rated Openings, 3-Hour Duration: Thresholds, where scheduled, to extend full jamb depth.
4. Acoustic Openings: Set units in full bed of sealant per Section 07 92 00 “Sealants;” leave no air space between threshold and substrate.
5. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.

G. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Do not leave exposed unfilled/uncovered silencer holes.

H. Cylinders:

1. Provide cylinder housings, collars, rings & springs as recommended by the manufacturer for proper installation.
2. Provide cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets.
3. Provide cylinder guards for all exposed cylinders at exterior perimeter doors.
4. Coordinate and provide as required for related sections.

2.8 Keying

A. Provide new factory registered keying system by Medeco, complying with guidelines in BHMA A156.28, Appendix A. All NOCCCD Anaheim Campus lock and keying requirements by Controlled Key Systems, Inc. Coordinate with District representative and Paul Wojdynski, Controlled Key Systems, Inc., 17248
Red Hill Avenue, Irvine, CA, 92614. Phone: (949) 756-1121. Incorporate decisions made in keying conference, and as follows:

1. No Master Key System: Cylinders are operated by change keys only.
2. Master Key System: Cylinders are operated by a change key and a master key.
3. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
4. Great Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great grand master key.
5. Existing System: Master key or grand master key locks to Owner's existing system.
6. Existing System: Re-key Owner's existing master key system into new keying system.
7. Keyed Alike: Key all cylinders to same change key.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation: “DO NOT DUPLICATE.”

2. Quantity: In addition to the following, provide two extra keys for each lock:
   b. Master Keys: Five.
   d. Great Grand Master Keys: Five.

C. Deliver keys and cylinders directly to Owner’s representative for storage.

2.9 Sliding Door Hardware

A. BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories for complete installation. Provide anodized aluminum rated for doors up to 300 lbs.

2.10 Fasteners

A. Furnish type, quality, size and quantity for long-life installation under hard usage. Conform to manufacturer’s instructions and recommendations for fasteners and installation and the following minimum requirements. Provide fasteners which are suitable for the substrate.

B. Provide expansion shields, hex bolts and other anchors and fasteners as recommended by hardware manufacturer. Do not use toggle anchors or powder-actuated driven fasteners.

C. Provide fastener finish that match hardware item. Provide stainless steel fasteners at aluminum and stainless steel hardware. Provide corrosion-resistant stainless steel at exterior exposure, unheated spaces and damp atmospheres.

D. Provide fasteners at fire doors that conform to labeling requirements of door, frame and hardware. At wood doors, provide sex-nut through-bolts for operating hardware unless permitted otherwise by hardware listing.

E. Do not use toggle or wing-type anchors. Do not use powder-actuated driven fasteners.

F. Exposed Through-Bolts: Do not use SNB, grommet nuts, sleeve nuts or other such clamping type fasteners, intent is for minimal exposed hardware. Coordinate with wood doors; ensure provision of proper blocking to support wood screws for mounting panic hardware and door closers. Coordinate with
metal doors and frames; ensure provision of proper reinforcement so support machine screws for mounting panic hardware and door closers.

G. Provide door hardware fasteners manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Conceal fasteners to greatest extent possible. Where exposed fasteners are needed, provide Phillips flat head screws countersunk 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. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:
   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface-mounted exit devices.

4. Spacers or Sex Bolts: For through bolting of hollow metal doors.

5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

6. Install screws with silicone sealant applied to tip of screw to prevent screw from working loose.

2.11 Fabrication

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels.

B. Produce door hardware units of base metal, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

2.12 Finishes

A. Standard: BHMA A156.18, as indicated in door hardware sets.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Variations in appearance of abutting or adjacent pieces are not acceptable. Noticeable variations in the same piece are not acceptable.

D. At contractor’s option, stainless steel may be provided instead of satin chrome plating. Where stainless steel is indicated, substitution of satin chrome plating will not be acceptable.

E. Color shall be selected by Architect from manufacturer’s full range of colors including custom colors.
F. Split finish Satin Chrome and Dark Bronze Finish: Scheduled as 626 and 613 as specified

G. Powder coat door closers to match other hardware, unless otherwise noted.

H. Aluminum: Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

I. Primer Coat:
   1. Primer on steel: BHMA 600(PC).
   2. Primer on brass or bronze: BHMA 163(PC).

PART 3 - Execution

3.1 Installer Requirements

A. Acceptable installers:
   1. Can read and understand manufacturers’ templates, suppliers’ hardware schedules and printed installation instructions.
   2. Can readily distinguish drywall screws from manufacturers’ furnished fasteners.
   3. Available to meet with manufacturers’ representatives and related trades to discuss installation of hardware and can explain and discuss the correct operation and installation of each hardware item.
   4. Thoroughly trained and experienced in the installation of the type of hardware required for this project.

3.2 Examination

A. Examine doors and frames, with hardware installer and hardware expert present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Verify that doors and frames are ready to receive work and that dimensions are as indicated on shop drawings.
   1. Conform to the mounting locations required, except where otherwise shown on Drawings, otherwise indicated in reference standards or otherwise required by governing authorities having jurisdiction.
   2. In case of conflict or variance with mounting methods or locations, submit RFI in writing to Architect listing all conflicts or variances, along with recommended mounting methods and locations for clarification and direction.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation. Verify that power supply is available to power operated devices.

C. Examine roughing-in for alarm and access control system to verify wiring locations and connection points.

D. Ensure that walls and frames are square and plumb before hardware installation.

E. Examine all hardware sets and packages:
   1. Verify that each opening has the appropriate and correct hardware. Verify with hardware schedule.
   2. Verify that appropriate fasteners have been provided.
   3. Ensure that all hardware on fire and exit doors bears appropriate UL label.
F. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation indicates acceptance of substrates and conditions by contractor.

3.3 Preparation

A. Steel Doors and Frames: Comply with DHI A115 Series. Drill and tap doors and frames according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

C. Before installing stops, determine proposed locations of furniture items, fixtures, and other items to be protected by the stop’s action.

D. Existing frames and doors to be retrofitted with new hardware:
   1. Carefully remove existing hardware, tag and bag, and turn over to Owner.
   2. Field verify conditions and dimensions prior to ordering hardware. Fill existing hardware cut outs not being reused by the new hardware. Remove existing hardware not being reused, return to Owner unless directed otherwise.
   3. Remove existing floor closers not scheduled for reuse, fill cavities with concrete and finish smooth.
   4. Cut and weld existing steel frames currently prepared with 2-3/4” height strikes. Cut an approximate 8-inch section from the strike jamb and weld in a reinforced section to accommodate specified hardware's strike.
   5. Patch and weld flush filler pieces into existing door hardware preparations in steel doors and frames, grind and leave surfaces smooth and invisible to modifications.
   6. Patch and fill wood frames and doors with solid wood dutchments before cutting for new hardware. Do not reuse existing screw holes, fill with dowel plugs and re-pilot.

3.4 Installation

A. Mount door hardware units at heights to comply with all fire, life safety, security and accessibility requirements and the following:
   1. Locate hardware per SDI-100.
   3. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
   5. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
   6. Hardware installation at fire doors and exit doors:
      a. Install fire door hardware in conformance to NFPA 80.
      b. Install exit door hardware in conformance to NFPA 101.
      c. Ensure that all hardware on fire and exit doors bears appropriate UL label.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved. Use templates provided by hardware item manufacturer.
1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3. Gaskets: Install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.

4. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.

5. Use suitable fasteners of same material and finish as hardware items, or submit Request for Substitution with Architect.

6. Replace fasteners damaged by power-driven tools.

C. Boxed Power Supplies: Locate power supplies above ceilings. Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

D. Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07 92 00 "Sealants."

E. Locate floor stops no more than 4 inches from walls and not within paths of travel. See Part 2.3 Hinging Methods regarding hinge widths, door should be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.

F. Core concrete for exterior door stop anchors. Set anchors in approved non-shrink grout.

G. Locate overhead stops for minimum 90 degrees and maximum allowable degree of swing.

H. Drill pilot holes for fasteners in wood doors and/or frames. Centerpunch hole locations before using self-drilling type screws to prevent skating. Replace screws that are not centered in their holes.

I. Lubricate and adjust existing hardware to remain. Carefully remove and turn over to Owner items to be salvaged.

J. Fill existing hardware cut outs not being used by the new hardware. Remove existing hardware not being reused.

K. Disable or remove existing floor closers where they exist. If disabled cut or remove spindle.

L. Where existing wall conditions will not allow door to swing using the scheduled hinges, provide wide-throw hinges and if needed extended arms or closers.

M. Provide proper brackets to accommodate the mounting of closers on doors with flush transoms.

N. After fitting hardware to doors, remove all finish hardware, carefully replace in properly marked boxes, and place in storage until painting and finishing is completed. After painting and finishing is completed, permanently install finish hardware. Comply with DH-02 for installation of hardware.

O. Provide expansion anchors for attaching hardware items to concrete or masonry.

P. For steel door surfaces fasten light hardware to door face with sheet metal screws. Fasten heavy and operating hardware to threaded internal reinforcement with machine screws.
3.5 Field Quality Control

A. Submit written confirmation by door hardware supplier and Architectural Hardware Consultant on letterhead that hardware is complete and correctly installed and adjusted. If corrections are necessary, perform adjustments and replacement of hardware prior to demonstration at no change in Contract Time or Contract Sum.

B. Owner will engage a qualified independent Architectural Hardware Consultant (AHC) to perform inspections and to prepare inspection reports. Independent AHC 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.

3.6 Adjusting

A. 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 after balancing of HVAC system is complete, and to comply with referenced accessibility requirements. Measure door opening force with a mechanical force gauge Wagoner Instruments FDK40.

1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
2. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
3. Hardware damaged by improper installation or adjustment methods; repair or replace to Owner’s satisfaction.
4. Adjust doors to fully latch with no more than 1 pound of pressure.
5. Adjust delayed action closers on fire-rated doors to fully close from fully opened position in no more than 10 seconds.
6. Adjust door closers to comply with all regulatory requirements.
7. Make final adjustment to door operating hardware after mechanical/ventilation system is running balanced and balancing reports are submitted to and accepted by Owner.

B. Approximately six months after date of Substantial Completion, installer and Owner's Architectural Hardware Consultant (AHC) shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware. Installer to provide letter to Owner that upon completion installer has visited the project and has accomplished the following:

1. Re-adjusted hardware.
2. Evaluate maintenance procedures and recommend changes or additions, and instruct Owner’s personnel.
3. Identify items that have deteriorated or failed and replaced parts.

3.7 Cleaning and Protection

A. Clean adjacent wall, frame, door and other surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide factory or field applied protective coverings as necessary to prevent marring and soiling. Maintain factory protective coverings until ready for final cleaning.
D. Remove construction keying and install permanent keying immediately prior to hardware demonstration; provide key control as directed by Owner through Owner’s Representative.

E. Adjust and check each item of hardware at each door, to ensure proper operation or function of every component. Replace components, which cannot be adjusted, to operate freely and smoothly. Where door hardware is installed more than 30 days prior to Substantial Completion review, re-inspect and adjust hardware immediately prior to demonstration.

F. Clean hardware for Substantial Completion review.

3.8 Demonstration

A. In the presence of project inspector, demonstrate proper operation of all doors.

B. Demonstrate that permanent keys operate applicable locks and deliver keys immediately to Owner.

C. Demonstrate that all fire and exist doors operate improper sequence and with no greater than specified maximum force on operating hardware.

D. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Section 01 79 00 "Demonstration and Training." Demonstrate all electrical, electronic and control systems. Include demonstration for adjustment and maintenance procedures.

E. Furnish as-builts/as-installed schedule with closeout documents, including keying schedule, wiring diagrams, manufacturers’ installation, adjustment and maintenance information, and supplier’s final inspection report.

3.9 Door Hardware Schedule

A. Hardware is described generally. Select and order door hardware according to manufacturer’s full catalog number, providing all features specified and necessary for project conditions.

B. Provide sub-groups of hardware as necessary.

C. Application of door hardware sets is indicated on the door schedule on the Drawings.

**Hardware Sets**

**SET #100**

<table>
<thead>
<tr>
<th>Hardware Sets</th>
<th>Quantities</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Hinges</td>
<td></td>
<td>FBB179 4 1/2 X 4 1/2 NRP US26D ST</td>
</tr>
<tr>
<td>1 Mullion</td>
<td></td>
<td>KR4954 SP28 VO</td>
</tr>
<tr>
<td>1 Exit Device</td>
<td></td>
<td>AX PA 99EO US26D VO</td>
</tr>
<tr>
<td>1 Exit Device</td>
<td></td>
<td>AX PA 99L-2 x 996L-R&amp;V 03 US26D VO</td>
</tr>
<tr>
<td>3 Rim Cylinder</td>
<td></td>
<td>Owners Standard</td>
</tr>
<tr>
<td>2 Closer</td>
<td></td>
<td>4040 XP HEDA AL LC</td>
</tr>
<tr>
<td>2 Door Silencers</td>
<td></td>
<td>1229A BLACK TR</td>
</tr>
<tr>
<td>1 Threshold</td>
<td></td>
<td>Per Detail AL NA</td>
</tr>
</tbody>
</table>
SET #101
Doors: 1003-1, 1005-1, 703-1, 705-1

1 Fire Exit Device
   AX PA 99L-F x 996L-R&V-BE 03
   US26D VO

   NOTE: Re-use balance of existing hardware.

SET #102
Doors: 710-1

3 Hinges
   FBB179 4 1/2 X 4 1/2
   US26D ST

1 Privacy Set
   ML2030 Series
   626 CR

1 Closer
   4040 XP REG
   AL LC

1 Kick Plate
   K0050 10" x 2" LDW x CSK B4E
   630 TR

1 Mop Plate
   K0050 6' x 1" LDW X CSK B4E
   630 TR

1 Floor Stop
   1211
   626 TR

1 Gasketing
   5050 @ Head & Jambs
   NA

1 Threshold
   Per Detail
   AL NA

SET #103
Doors: 711-1

3 Hinges
   FBB179 4 1/2 X 4 1/2
   US26D ST

1 Classroom Intruder
   ML2052 Series
   626 CR

2 Mortise Cylinder
   Owners Standard

1 Floor Stop
   1211
   626 TR

3 Door Silencers
   1229A
   BLACK TR

SET #104
Doors: 712-1, 721-1, 732-1

3 Hinges
   FBB179 4 1/2 X 4 1/2
   US26D ST

1 Storeroom Lockset
   ML2057 Series
   626 CR

1 Mortise Cylinder
   Owners Standard

1 Closer
   4040 XP REG
   AL LC

1 Floor Stop
   1211
   626 TR

3 Door Silencers
   1229A
   BLACK TR

SET #105
Doors: 1023-1, 1023-2, 713-1, 717-1, 724-1, 726-1

3 Hinges
   FBB179 4 1/2 X 4 1/2 NRP
   US26D ST

1 Fire Exit Device
   AX PA 99L-F-2 x 996L-R&V
   US26D VO

1 Rim Cylinder
   Owners Standard

1 Closer
   4040 XP EDA
   AL LC

1 Kick Plate
   K0050 10" x 2" LDW x CSK B4E
   630 TR

1 Base Stop
   1475
   626 DJ

1 Gasketing
   5050 @ Head & Jambs
   NA

1 Threshold
   Per Detail
   AL NA
**SET #106**

Doors: 715-1

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<tbody>
<tr>
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<td>FBB179 4 1/2 X 4 1/2 NRP</td>
<td>US26D</td>
<td>ST</td>
</tr>
<tr>
<td>1 Fire Exit Device</td>
<td>AX PA 99L-F-2 x 996L-R&amp;V</td>
<td>US26D</td>
<td>VO</td>
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<tr>
<td>1 Closer</td>
<td>4040 XP EDA</td>
<td>AL</td>
<td>LC</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K0050 10&quot; x 2&quot; LDW x CSK B4E</td>
<td>630</td>
<td>TR</td>
</tr>
<tr>
<td>1 Wall Bumper</td>
<td>1270CX</td>
<td>626</td>
<td>TR</td>
</tr>
<tr>
<td>1 Gasketing</td>
<td>5050 @ Head &amp; Jambs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>Per Detail</td>
<td>AL</td>
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**SET #107 - Sliding**

Doors: 1024-1, 1024-2, 714-1, 725-1, 727-1

<table>
<thead>
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<th>Item</th>
<th>Description</th>
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<th>Finish</th>
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<td>1 Set Sliding Door Hardware</td>
<td>BP150N-00 Series</td>
<td>ST</td>
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</tr>
<tr>
<td>1 Pair BTB Pulls</td>
<td>7200P</td>
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**SET #108**

Doors: 716-1, 718-1

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<tr>
<td>3 Hinges</td>
<td>FBB179 4 1/2 X 4 1/2 NRP</td>
<td>US26D</td>
<td>ST</td>
</tr>
<tr>
<td>1 Passage Set</td>
<td>ML2010 Series</td>
<td>626</td>
<td>CR</td>
</tr>
<tr>
<td>1 Floor Stop</td>
<td>1211</td>
<td>626</td>
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</tr>
<tr>
<td>1 Gasketing</td>
<td>5050 @ Head &amp; Jambs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>Per Detail</td>
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**SET #109**

Doors: 719-1

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<tr>
<td>3 Hinges</td>
<td>FBB179 4 1/2 X 4 1/2 NRP</td>
<td>US26D</td>
<td>ST</td>
</tr>
<tr>
<td>1 Classroom Intruder</td>
<td>ML2052 Series</td>
<td>626</td>
<td>CR</td>
</tr>
<tr>
<td>2 Mortise Cylinder</td>
<td>Owners Standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Closer</td>
<td>4040 XP HCUSH</td>
<td>AL</td>
<td>LC</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K0050 10&quot; x 2&quot; LDW x CSK B4E</td>
<td>630</td>
<td>TR</td>
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<td>1 Gasketing</td>
<td>5050 @ Head &amp; Jambs</td>
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<td></td>
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<tr>
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<td>Per Detail</td>
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**SET #110**

Doors: 1010-1, 1011-1, 1012-1, 1013-1, 1018-1, 1028-1, 1029-1, 720-1, 722-1, 731-1, 734-1, 735-1

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<td>ST</td>
</tr>
<tr>
<td>1 Office Lockset</td>
<td>M2053 Series</td>
<td>626</td>
<td>CR</td>
</tr>
<tr>
<td>1 Mortise Cylinder</td>
<td>Owners Standard</td>
<td></td>
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</tr>
<tr>
<td>1 Wall Bumper</td>
<td>1270CX</td>
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<tr>
<td>3 Door Silencers</td>
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**Door Hardware**

08 71 00 - 22
SET #111

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<th>Type</th>
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<th>Other Details</th>
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</thead>
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<td>3 Hinges FBB179 4 1/2 X 4 1/2 US26D ST</td>
<td>1 Office Lockset M2053 Series 626 CR</td>
<td>1 Mortise Cylinder Owners Standard</td>
<td>1 Closer 4040 XP REG AL LC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Floor Stop 1211 626 TR</td>
<td>1 Threshold Per Detail AL NA</td>
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SET #112

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<th>Other Details</th>
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<tr>
<td>112</td>
<td>1026-1, 1027-1, 729-1, 730-1, 733-1</td>
<td>3 Hinges FBB179 4 1/2 X 4 1/2 US26D ST</td>
<td>1 Office Lockset M2053 Series 626 CR</td>
<td>1 Closer 4040 XP REG AL LC</td>
<td>1 Wall Bumper 1270CX 626 TR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Gasketing 5050 @ Head &amp; Jambs</td>
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SET #113

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<th>Other Details</th>
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</thead>
<tbody>
<tr>
<td>113</td>
<td>1000-1</td>
<td>3 Hinges FBB179 4 1/2 X 4 1/2 NRP US26D ST</td>
<td>1 Exit Device AX PA 99L-2 x 996L-R&amp;V 03 US26D VO</td>
<td>2 Rim Cylinder Owners Standard</td>
<td>1 Closer 4040 XP HCUSH AL LC</td>
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SET #114

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</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td>1014-1, 1015-1</td>
<td>3 Hinges FBB179 4 1/2 X 4 1/2 US26D ST</td>
<td>1 Classroom Intruder ML2052 Series 626 CR</td>
<td>1 Mortise Cylinder Owners Standard</td>
<td>1 Closer 4040 XP REG AL LC</td>
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<td></td>
<td></td>
<td>1 Floor Stop 1211 626 TR</td>
<td>1 Threshold Per Detail AL NA</td>
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### SET #115

**Doors: 1016-1**

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<td>FBB179 4 1/2 X 4 1/2 NRP</td>
<td>US26D ST</td>
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</tr>
<tr>
<td>1 Set Auto Flush Bolts</td>
<td>3820 X 3810</td>
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<tr>
<td>1 Dustproof Strike</td>
<td>3910</td>
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</tr>
<tr>
<td>1 Classroom Intruder</td>
<td>ML2052 Series</td>
<td>626 CR</td>
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<tr>
<td>1 Mortise Cylinder</td>
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<tr>
<td>1 Closer</td>
<td>4040 XP HCUSH</td>
<td>AL LC</td>
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<td>2 Door Silencers</td>
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**NOTE:** Closer on active door only.

### SET #116

**Doors: 1017-1, 1032-1, 1033-1**

<table>
<thead>
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<tr>
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<tr>
<td>1 Wall Bumper</td>
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# Opening List

*(For Reference Only)*

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Door Hardware
08 71 00 - 25
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END OF SECTION 08 71 00
SECTION 08 80 00 - Glazing

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 07 92 00 “Sealants.”
2. Section 08 11 13 “Steel Doors & Frames.”
3. Section 08 71 00 “Door Hardware”
4. Section 10 11 00 “Visual Display Units.”
5. Section 10 28 16 “Toilet and Bath Accessories.”
6. Section 10 44 00 “Fire-Protection Specialties.”

1.2 References

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

5. ASTM C 1376 Standard Specification for Pyrolitic and Vacuum Deposition Coatings on Flat Glass.

B. National Fire Protection Association (NFPA):


C. California Building Code (Referenced UBC Standards):

1. UBC-7-2: Methods for Fire Tests of Door Assemblies.
2. UBC-7-4: Methods for Fire Tests of Window Assemblies.

D. American National Standards Institute (ANSI):


1.3 Definitions

A. Deterioration of Coated Glass: Defects developed from normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
B. Deterioration of Laminated Glass: Defects developed from normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 Performance Requirements

A. Performance Requirements: Provide a fire rated glazing manufactured, fabricated and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure. Provide fire rating not less than as shown on the Drawings. Window assemblies with ratings of less than 60 minutes shall be tested in accordance with ASTM E 163, NFPA 257, UBC 7-4, and UL 9 Standard Test Methods. Fire tests shall be conducted by an approved independent testing laboratory, similar to Warnock Hersey International or Underwriters Laboratories, Inc.

B. Assemblies shall be labeled in accordance with requirements of listings indicated.

1.5 Submittals

A. Product Data: For each glass product and glazing material indicated.

1. Glass.
2. Glazing channels.
3. Glazing beads, compounds, and sealants.
4. Glazing tape.

B. Submit shop drawings showing details of each type glazing system indicating sizes, shapes, material and quantity. Show details indicating sealant thickness and profile, bite on glass, glass edge clearance, depth of rabbet and thickness of glass. Identify gasket materials, side spacer blocks, and setting blocks. Show weepage system in glass pockets. Details shall be full size.

C. Samples: For each glass product, color, tint and pattern in the form of 12-inch-square samples with smooth ground edges. 12-inch-long samples for sealants and gaskets. Install sealant samples between two strips of material representative in color of the adjoining framing system. On exterior glass samples clearly indicate interior and exterior sides without disrupting appearance of sample. All samples of glass shall bear required markings, such as tempered glass indicators, manufacturer’s name, and code required marks.

1.6 Quality Assurance

A. Provide an experienced installer who has completed glazing similar in material, design, and extent to that indicated for this project; whose work has resulted in glass installations with a record of successful in-service performance for a minimum of 5 years; and who employs glass installers for this project who are certified under the National Glass Association's Certified Glass Installer Program as Level 2 Senior Glaziers and Level 3 Master Glaziers.

B. Obtain each type of glass and glazing product through one source from a single manufacturer with a minimum of 10 years in the manufacturing and distribution of glass products.

C. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.
D. Grading and Labeling: Grade and label each light stating quality and grade of glass and manufacturer’s name and brand designation. Leave labels intact until removal is directed by Architect.

E. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than 4 (four) pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the work.
4. For materials failing tests, obtain sealant manufacturer’s written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

F. Provide glazing for fire-rated door assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

G. Provide glazing for fire-rated window assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

H. Provide safety glazing products that comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to requirements, obtain safety glazing products permanently marked with certification label of certification agency acceptable to authorities having jurisdiction.
2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lights more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lights 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
3. Comply with all the applicable codes and ordinances, including California Building Code (CBC).

I. Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division’s “Laminated Glass Design Guide” and GANA’s “Glazing Manual.”

J. Provide insulating-glass certification permanently marked either on spacers or on at least one component light of units with appropriate certification label of the Insulating Glass Certification Council.
K. Do not start field glazing work until the outdoor temperature is above 40° F and rising, unless approved provisions are made to warm the glass and rabbet surfaces. Create an environment sufficiently dust free for sealant and glazing work. Do not perform glazing work during damp or rainy weather.

L. Do not install mirrors until required temperature and relative humidity conditions have been stabilized and will be maintained in installation areas. Provide sufficient ventilation to prevent condensation of moisture on glazing work during installation.

M. Comply with all instructions, recommendations, and warranty requirements of glass and glazing product manufacturers.

N. Conduct pre-fabrication meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make necessary adjustments in fabrication strategy to meet requirements without additional cost or time to Contract.

O. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.7 Delivery, Storage, and Handling

A. Deliver, store and handle glazing materials according to manufacturer’s written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1. Package, handle, and store mirrors to that water does not touch mirror edges.
2. Protect glass edges against chipping and other damage.
3. Furnish labels identifying each type of glass. Keep labels in place until glass is installed.
4. Store glass and glazing products in controlled environment, out of sunlight, so that temperature does not go above 80° F. Bring glazing materials to at least 40° F, or higher temperature if recommended by manufacturer, before applying.

B. Deliver products to the site in unopened containers, labeled plainly with manufacturers’ names and brands. Do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.8 Project Conditions

A. Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40° F.

B. Verify actual measurements for openings by field measurements before shop drawing preparation and show recorded measurements on shop drawings. Where field measurements cannot be taken due to progress of work, coordinate with appropriate trades to determine dimensions and proceed with shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.9 Warranty

A. Provide warranty made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in Article 1.3 "Definitions" and against loosening, air or water leakage, glass popouts and other defects and deterioration including without limitation, shrinkage,
loss of seal, exposure to ozone, elements, smog and other air pollution, and commercial glass cleaners, f.o.b. the nearest shipping point to project site, within specified warranty period. Warranty Period: 5 years.

B. Provide warranty made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in Article 1.3 "Definitions" and against loosening, air or water leakage, glass popouts and other defects and deterioration including without limitation, shrinkage, loss of seal, exposure to ozone, elements, smog and other air pollution, and commercial glass cleaners, f.o.b. the nearest shipping point to project site, within specified warranty period. Warranty Period: 5 years.

C. Provide warranty made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in Article 1.3 “Definitions” and against loosening, air or water leakage, glass popouts and other defects and deterioration including without limitation, shrinkage, loss of seal, exposure to ozone, elements, smog and other air pollution, and commercial glass cleaners, f.o.b. the nearest shipping point to project site, within specified warranty period. Warranty Period: 5 years.

D. Provide warranty that basic glass products and installation shall be free from defects for not less than two years.

E. Provide warranty that mirror glass shall show no evidence of silver spoilage for a period of not less than 5 years.

F. Upon notification of defects, within the warranty period, party providing warranty shall remove and replace defective products with new products at no cost to Owner.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

1. AFG Industries, Inc.; Krystal Klear.
2. Pilkington Building Products North America; Optiwhite.
3. PPG Industries, Inc.; Starphire.

2.2 Glass Products

A. Float Glass: ASTM C 1036, Type I Ultra-Clear (Low-Iron) Float Glass transparent flat glass, Quality-Q3, Class I with a minimum 91 percent visible light transmission and a minimum solar gain coefficient of 0.87.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed
2. For uncoated glass, comply with requirements for annealed float glass.
3. For coated vision glass, comply with requirements for coated vision glass.
4. Provide Kind FT (fully tempered) float glass in place of annealed float glass where safety glass is indicated and where needed to resist thermal stresses induced in individual glass lights and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.

D. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

1. Polyvinyl butyral interlayer with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lights and installation. Laminate lights in autoclave with heat plus pressure.
2. Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

2.3 Fire-Rated Glazing Products

A. Monolithic Ceramic Glazing Material: Proprietary product in the form of clear flat sheets of 3/4-inch nominal thickness weighing 2.5 lb/sq. ft., and as follows:

1. Fire-Protection Rating: As indicated for the fire window in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Product: "Premium FireLite" (polished on both surfaces) by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products or approved equal.

B. Laminated Ceramic Glazing Material: Proprietary Category II safety glazing product in the form of 2 lights of clear ceramic glazing material laminated together to produce a laminated light of 3/4-inch nominal thickness; polished on both surfaces; weighing 4 lb/sq. ft.; and as follows:

1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Polished on all surfaces, transparent.
3. Product: "FireLite Plus" by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products or approved equal.

C. Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory (Warnock Hersey or Underwriters Laboratory), fire rating period and safety glazing standards.

D. Glazing materials installed in hazardous locations, subject to human impact, shall be fully tempered, certified and permanently labeled as meeting applicable code requirements and as referenced in NFPA 80:

1. ANSI Z97.1, 100 ft. /lb.
2. CPSC 16 CFR 1201, Category II, 400 ft. /lbs.

2.4 Mirror Glass

A. Provide custom cut mirror glass, 3/16 inch minimum thickness, edges ground and polished, sealed as specified below, ASTM C 1036, Type 1, Class 1.

1. Tempering: Fully temper mirrors in locations required by 16CFR1201 and authorities having jurisdiction. Otherwise provide untempered mirror glass. Tempering shall comply with ASTM C 1048, Kind FT, Condition A, Type 1 or 2, Quality q3.
2. Glass Quality: Mirror Select.
3. **Edges:** Square.

   B. Provide continuous bright chrome plated mounting, brass J-mold at bottom and adhesive applied at back surface. Secure J-mold with screws into sides or solid backing.

   C. Provide sizes as scheduled or indicated on Drawings.

   D. Provide moisture-resistant heavy duty mirror back coating, Palmer Mirror-Bac Paint, Poly-Glaze by Carolina Mirror or Diamondback by PPG or other type approved by Architect.

   E. Provide clear mirror edge sealant, PPG UC-4401 Mirror Edge Seal or approved equal. Treat and seal so as to prevent moisture, chemical, and atmospheric penetration of backing.

   F. Provide adhesive compound formulated specifically for setting mirrors by spot application method (60% coverage) without support, to be used in 1/8 inch to 1/4 inch thickness and approved as compatible with mirror coating system by the mirror manufacturer. Provide adhesive in heavy consistency for use with mirrors over rough or uneven surfaces. Provide one of or equal to the following:

   1. Mirro-Mastic, by Palmer Products.
   2. Ultra/Bond, by C. Gunther.

### 2.5 Glazing Materials

A. Provide extruded dense gaskets of EPDM, ASTM C 864 of profile and hardness required to maintain watertight seal. Color: Black.

B. Provide flame resistant glazing materials at fire rated assemblies.

C. Provide glazing sealants indicated, complying with the following requirements:

   1. Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

   2. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

   3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer’s full range of colors.

D. Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates. Type and Grade: S (single component) and NS (nonsag). Class: 100/50.

   1. Subject to requirements, provide one of or equal to the following:

      a. GE Silicones; SilPruf SCS2000.
      d. Tremco; Spectrem 3.

E. Provide glazing sealants for fire-resistant glazing products that are identical to products used in test assemblies to obtain fire-protection rating.
F. Provide closed-cell, PVC expanded cellular glazing tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

G. Provide EPDM setting blocks of sufficient hardness to compress no more than 20% under weight of glass.

H. Provide aluminum, compatible stainless steel, or other plated or corrosion resistant non-resilient shims and spacers for leveling and securing framing members. Do not use wood for shims.

I. Provide closed-cell or waterproof-jacketed compressible filler rods of neoprene, tested for compatibility with specified glazing sealants, of 5 of 10 psi compression strength (25% deflection), recommended by sealant manufacturer for use in glazing channel to prevent sealant exudation from the channel. ASTM 1330.

J. Provide cleaners and solvents as recommended by glazing material manufacturer for each type of glass, glazing material and substrate.

K. Provide accessories as required for a complete installation. Accessories shall include glazing points, clips, shims, angles, beads, and spacer strips.

L. Provide noncorroding metal accessories.

M. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

2.6 Miscellaneous Glazing Materials

A. Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Provide cleaners, primers, and sealers recommended by sealant or gasket manufacturer.

C. Provide EPDM continuous extrusion spacers with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lights in plate for installation indicated.

D. Provide EPDM edge blocks of hardness needed to limit glass lateral movement (side walking).

E. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.7 Fabrication of Glazing Units

A. Fabricate glazing units in sizes required to glaze openings indicated for project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
PART 3 - Execution

3.1 Examination

A. Examine framing, with installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners. Where frames are out of square, out of plane, subject to excessive deflection, or where substrates contain bond breaking substances, moisture, unsound material, or where there are other conditions unsuitable for proper installation or performance of the glazing work, do not start glazing work until defects have been corrected.

2. Presence and functioning of weep system.

3. Minimum required face or edge clearances.

4. Effective sealing between joints of glass-framing members.

5. Determine prior to start of field glazing that framing, flashing, fasteners and trim are of proper materials and will not create staining problems on glass.

6. Remove dust and other bond breaking substances from surfaces to be glazed.

7. Do not glaze wet, damp, or uncured surfaces. Do not place glazing components or glass in frame channels and rabbets that are wet.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with glass and glazing installation indicates contractor’s acceptance of framing and conditions affecting glazing.

3.2 Preparation

A. Unless otherwise specified or approved, conform to applicable recommendations in the GANA – Glazing Manual and GANA – Glazing Sealing Systems Manual. Shop prepare all glass to be field installed.

1. Cut glass and grind smooth all edges that will be exposed in finish work. Do not field cut tempered glass.

2. Remove dust and other bond breaking substances from surfaces to be glazed.

B. For exterior glazing, do not start glazing until each light is provided with the appropriate number and spacing of weepholes as recommended by frame manufacturer’s written installation and warranty requirements.

C. Clean glazing channels, gutters, glass pockets, and other framing members receiving glass immediately before glazing. Remove all substances and coatings not firmly bonded to substrates, including but not limited to; dirt, oil, grease, fireproofing, surface dust, debris, and frost. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

D. Remove loose particles present or resulting from cleaning. Remove protective coatings and fabrication oils and residue on metallic surfaces with solvents that leave no residue. Do not allow solvent to air dry without wiping. Use only clean lint-free towels for wiping of surfaces.

E. Do not glaze when the ambient temperature and weather conditions cause frost or moisture or condensation on framing or during damp weather unless approved measures to eliminate these conditions are used.

F. Cut glass accurately to sizes required to the openings and in such a way that edges are smooth and straight. Clean glass free from dust, oil, etc., and wipe clean immediately before installation. Do not field cut tempered glass.
G. Set, remove and later reset glazing stops so as to avoid marking or defacing any portion of the frames, stops, settings, etc. Prime surfaces of openings properly where recommended in writing by the sealant manufacturer.

### 3.3 Glazing, General

A. Watertight and air tight installation of each piece of glass is required. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications. Each installation must withstand normal temperature changes, wind loading, impact loading without a failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight or air tight, deterioration of glazing materials and other defects in the work.

B. Protect glass from edge damage during handling and installation as follows:

1. Handle and install glazing materials in accordance with the manufacturer’s instructions.
2. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lights with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer’s label.
3. Remove damaged glass from project site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

C. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by project conditions during installation. Maintain minimum face distances on both sides of glass as per GANA guidelines.

D. Protect glass edges from damage during handling and installation. Remove damaged glass from project site and legally dispose of off project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

E. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

F. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

G. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lights.

H. Provide spacers for glass lights where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

I. Provide edge blocking where indicated or needed to prevent glass lights from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
J. Set glass lights in each series with uniform pattern, draw, bow, and similar characteristics. Orient glass so that wave and other distortions run horizontally. Set all tempered glass with tong marks concealed, consistently at top of opening.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

M. Install insulating glass units to comply with recommendations by IGMA, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.

N. Cutting and Fitting Glass: Accurately cut and fit glass to opening size. Provide clearance for expansion. Cut and set glass to keep wave lines horizontal. Ensure sharp, clean cut glass edges.

O. Force sealants into channel to eliminate voids and to ensure complete or bond of sealants to glass and channel surfaces.

P. Tool exposed surfaces of glazing liquids and compounds to provide a substantial “wash” away from the glass. Install pressurized tapes and gaskets to protrude slightly out of the channel, so as to eliminate dirt and moisture pockets.

Q. Clean and trim excess glazing materials from the glass and stops or frames promptly after installation, and eliminate stains and discolorations.

R. Do not attempt to cut, seam, nip or abrade glass which is tempered, heat strengthened, or coated.

S. Mitered Joints: Seam miter cut edges. Clean edge of glass to ensure proper adherence of sealant. Air pockets or voids in join are not acceptable.

T. Cut and set with the visible lines or waves horizontal.

U. Set glass with glass markings, such as manufacturer’s name, tempered glass designations, or code required indicators, right side up, level and straight. Locate markings in accordance with approved submittals, or if not indicated, in lower left-hand corner.

V. Glaze items using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA GM, GANA SM, SIGMA TB-3001, SIGMA TM-3000, and manufacturer’s recommendations.

W. Install wired glass in fire rated door vision lights and fire rated windows using sealant approved by the fire rating agency for use with the tested assembly.

X. Glaze after finish painting. Do not glaze in rabbets and steps that have not been painted.

Y. Completed installation is defined as no visible chips or fissures in glass; glazing is clean, straight, complete and continuous.
3.4 Tape Glazing

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Use tape of thickness to provide approximately 30 percent compression.

B. Install tapes continuously, break only at corners. Do not stretch tapes to make them fit opening. Tape together with no overlaps.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lights in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 Gasket Glazing (Dry)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lights in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

E. Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in glazing system.

3.6 Wall Mirror Installation

A. Preparation

1. Use gloves when handling mirrors to prevent damage to the face or backing from skin-borne salts or chemicals.
2. Do not install mirrors or new plaster, new gypsum board, new masonry or on a freshly painted wall.
3. Do not install in any new construction area where airborne solvents, heavy-duty cleaners or volatile chemicals are present.
4. Sub-surface shall be allowed to cure for a minimum of 120 hours before beginning mirror installation.

B. Secure channel support frame with screws into studs or solid backing or blocking. Attach channel to masonry or concrete walls with expansion anchors. Installation shall conform to mirror manufacturer’s instructions.

C. Apply one coat of moisture-resistant mirror back paint and allow to dry.

D. Seal edges of mirror with clear sealer.

E. Apply mastic to cover not less than 60 percent of back of mirror.

F. Install wall mirrors into channel support frame designed for blind attachment of mirror and with concealed mastic.

   1. Set mirror in channel on setting blocks and press against substrate to ensure bond of adhesive. Leave open 1/8 inch minimum ventilation space between mirror and substrate. Hold mirror in place until mastic sets.
   2. On mirror sizes greater than 18 inch square, provide bottom channel support frame, exposed clips at top and concealed mastic as herein specified.
   3. After mastic has set, clean mirrors using mild glass cleaner and soft cloths. Avoid wetting edges.

3.7 Cleaning and Protection

A. Cure glazing sealants and compounds in compliance with manufacturer’s instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

B. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces. Protect glass and glazing until completion and Final Acceptance.

C. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

D. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

E. Remove and replace glass and glazing that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period at no additional cost or time to Contract. Replace defective glass and glazing at no additional cost or time to Contract.

F. Identify glazed areas by hanging narrow streamers from walls and mullions. Do not mark glass nor affix decals to glass.

G. Leave labels in place until the installation is approved, except remove applied labels on tinted glass and on insulating glass units as soon as glass is installed.

H. Securely fix movable sash and door items or keep in a closed and locked position until glazing compound has thoroughly set.
I. Before final acceptance remove all protections and warning indications. Wash glass on both exposed surfaces in each area of project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

1. Thoroughly clean glass surfaces and remove labels, paint spots, and other defacements.
2. Avoid scratching glass or frames.
3. Mirror glazing shall receive special cleaning attention in accordance with manufacturer’s instructions and recommendations.

END OF SECTION 08 80 00
SECTION 09 22 16 - Non-Structural Metal Framing

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 12 00 “Structural Steel.”
2. Section 05 40 00 “Cold-Formed Metal Framing.”
3. Section 07 21 00 “Insulation.”
4. Section 07 84 00 “Through-Penetration Firestop Systems.”
5. Section 07 92 00 “Sealants.”
6. Section 08 11 13 “Steel Doors and Frames.”
7. Section 09 29 00 “Gypsum Board.”

1.2 Performance Requirements

A. ASTM C 645, nonstructural steel framing members.

B. ASTM C 954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inches to 0.112 inches in thickness.

C. ASTM A 1003, Standard Specification for Steel Sheet, Carbon, metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

D. Provide framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120° F.

E. Provide framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure.

F. Where stud sizes and connections have been indicated on Drawings, do not substitute with items of lesser size or capacity.

1.3 Submittals

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

B. Shop Drawings: Submit showing details for each typical wall, partition and ceiling system. Show all conditions of closures at and connections to, metal roof decking. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
1.4 Quality Assurance

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

1. Construct fire-resistance-rated partitions in compliance with tested assembly requirements indicated in drawings.
2. Rated assemblies to be substantiated, from applicable testing using the proposed products, by contractor.
3. Both metal framing and wallboard manufacturers must submit written confirmation that they accept the other manufacturer’s products as a suitable component in the assembly. Acceptance is as follows:
   a. If installation of both products is proper, no adverse effect will result in the performance of one manufacturer’s product by the other’s products.
   b. Combining products can be substantiated by required assembly tests.

B. Install suspension systems in accordance with ASTM C 754.

C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

D. Nonstructural components that are permanently attached to structures and their support attachments shall be designed and constructed to resist the effects of earthquake motions in accordance to local jurisdiction. Contractor shall determine appropriate gage of metal framing components based on loading, depths, and spacings indicated. In no case shall spans of metal framing elements exceed the limits indicated. Provide vertical studs with the following deflection limits:

   1. Walls with Heavy Finishes such as Plaster, Tile, Thin Set Masonry: L/360.
   3. Opening Framing: L/360.
   4. All other Applications: L/240.

E. Except as modified herein or required by code; conform metal support systems for plaster to the CLPCA Plaster/Metal Framing/Lath Manual and to MLSFA Metal Lathing and Furring.

F. Coordinate with other Sections for mockup requirements.

G. Conduct pre-installation meeting at project site to comply with requirements in Section 01 31 00 “Project Management and Coordination.”

H. Engage an experienced fabricator/installer who has at least 5 years metal framing experience similar in material, design, and extent to that indicated. Installer to provide workers and supervision that is experienced in the installation of metal framing.

1.5 Delivery, Storage and Handling

A. Deliver materials to the job site and store in ventilated dry locations. Storage area shall permit easy access for handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Promptly inspect delivered or defective materials, and order replacement materials as required. Any damaged or
defective materials shall be promptly removed from the job site. Remove damaged items and provide new items at no additional cost to Owner.

1.6 Coordination

A. Verify and coordinate work of trades before and during framing to assure adequate wall framing and backing is installed for all wall and ceiling attached such as but not limited to:

1. Grab bars.
2. Toilet compartments and urinal screens.
3. Toilet room accessories.
4. Plumbing fixtures.
5. Steel ladders.
6. Cabinets and shelving.
8. Chalkboards and marker-boards.
9. Other similar architectural features and accessories.
11. Light fixtures.
13. Exhaust and fume hoods.
15. Signage.
16. Wall mounted door bumpers and stops.
17. Corner guards.
18. Wall bumper rails.
19. Doors and windows.
20. Wall mounted hangers for plumbing, mechanical and electrical equipment, hangars and brackets.

B. Coordinate with other Sections to determine blocking and backing requirements.

PART 2 - Products

2.1 Non-Load-Bearing Steel Framing, General

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: ASTM C 645.
2. Protective Coating: Meeting requirements of ASTM C 645 C-channel, roll-formed from hot-dipped galvanized steel; complying with ASTM A 1003 or ASTM A 653, G40. A40 galvannealed products are not acceptable.
3. Dimpled components are acceptable.

B. Framing and support member gages specified herein are minimum. Use heavier stud gages where noted on the Drawings. Where required stud height exceeds code approvals or manufacturer’s recommendations, provide heavier gage studs and/or decrease stud spacing as necessary to conform to code approvals, at no additional cost to Owner.

2.2 Ceiling/Soffit Suspension System

A. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of L/360.
B. Tie Wire: ASTM A 641, Class 1 zinc coating, soft temper, 12 gage wire.

C. Hanger Attachments to Concrete: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency. Cast-in-place anchor, designed for attachment to concrete forms.

D. Wire Hangers: ASTM A 641, Class 1 zinc coating, soft temper, 6 gage.

E. Carrying Channels: Cold-rolled, commercial-steel sheet 18 gage minimum thickness and minimum 1/2-inch-wide flanges. Depth: 2-1/2 inches.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep. 24 gage minimum.

G. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission. Configuration: Asymmetrical.

2.3 Steel Framing for Framed Assemblies

A. Steel Studs and Runners: ASTM C 645. Determine base metal thickness based on design loads, size of framing span and spacing indicated on Drawings.

1. Dimpled Steel Studs and Runners:
   a. 20 gage.
   b. Depth: As indicated on Drawings.

2. Traditional Flat Material:
   a. 20 gage.
   b. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs. Subject to requirements, provide products by one of, or equal to, the following:

1. Dietrich Metal Framing.
2. Steel Network, Inc.
3. Superior Metal Trim; Superior Flex Track System (SFT).

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs. Subject to requirements, provide products by one of, or equal to, the following:

1. Dietrich Metal Framing; SLP-TRK.
2. Fire Trak Corp.; Fire Trak.


E. Cold-Formed Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges.
1. Subject to requirements, provide Dietrich Metal Framing; Spazzer® 9200 Bridging and Bracing Bar or approved equal.
2. U-Channel Depth: 1-1/2 inches.
3. Dietrich Metal Framing; EasyClip™ U-Series™ Clip Angle or approved equal.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0296 inch.
   2. Depth: As indicated on Drawings.

G. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
   Configuration: Asymmetrical.

H. Cold-Formed Furring Channels: 18 gage minimum thickness, with minimum 1/2-inch-wide flanges.
   1. Depth: As indicated on Drawings.
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness 22 gage minimum.
   3. Tie Wire: ASTM A 641, Class 1 zinc coating, soft temper, 14 gage minimum.

I. Z-Shaped Furring: With slotted web, face flange of 1-1/4-inches, wall attachment flange of 7/8 inch, 24 gage minimum, and depth required to fit insulation thickness indicated.

J. Radius Framing: Steel sheet runner for non-load-bearing curves, bends, variable radii and arches.
   2. Depth: As indicated on Drawings.

K. Headers and Jambs: Manufacturer’s proprietary shape used to form header beams and jambs, columns or posts, of web depths indicated, Unpunched, with stiffened flanges.

L. Flat Strap and Backing Plate: Sheet for blocking and bracing in length and width indicated.

2.4 Auxiliary Materials

A. Provide auxiliary materials that comply with referenced installation standards. Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Fasteners: Code approved and manufacturer recommended, wafer head screws, self drilling type, for metal to metal fastening complying with ASTM C 1002 or ASTM C 954.

C. Acoustical Foam Tape: Compressible, closed cell polyvinyl chloride foam with pressure sensitive adhesive, in rolls with protective release liner on non-adhesive face, 6 pcf density 1-inch-wide by not less than 1/4-inch thick, Norseal V370, manufactured by Norton Performance Plastics Corporation, or approved equal.

D. Acoustical Sealant: Permanently resilient single component silicone acoustical sealant.


Non-Structural Metal Framing
09 22 16 - 5
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.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation indicated acceptance of substrate and conditions by contractor.

3.2 Preparation

A. 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. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (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 on center.

C. 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 required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage. Repair areas where sprayed fire resistive materials are damaged or reduced below minimum thickness required.

3.3 General Installation

A. Installation Standard: ASTM C 754 and ASTM C 841, except comply with framing sizes and spacing indicated and comply with more stringent requirements of the Contract Documents.

1. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.

2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install all supplementary framing, blocking, and backing required to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently. Leave required gap to accommodate finish and joint systems.

E. Control joints for expansion and contraction in the walls shall be constructed with double studs separated as indicated on Drawings. Control joint spacing shall not exceed 30-feet. Ceiling-height door frames may be used as vertical control joints. Door frames of less than ceiling height may be used as control joints only if standard control joints extend to ceiling from both corners of top of door frame. Control joints between studs shall be filled with firesafing insulation in fire rated partitions.

F. Install 16 gage studs at wall-hung lavatories, urinals, grab bars, wall-hung casework, fixtures and equipment, and elsewhere as shown.
G. Spacing of studs for ceramic tile shall not exceed 16-inches when tile is thinset over Portland cement backer board, and 12-inches when mortar set over Portland cement plaster.

H. Where interior partitions are indicated with stud dimensions more than 6-inches in depth, install two rows of 16 gage, 2-1/2-inch minimum wide studs, using 1-1/2-inch runner channel cross ties at 16-inch centers vertically and 24-inch centers horizontally, all bolted, screw fastened, or welded in place.

I. Securely anchor metal framing to supporting structure. Screw, bolt, or weld wall framing at horizontal and vertical junctures to produce flush, even, true-to-line joints with minimum variation in plane and true position.

J. Install metal framing and accessories level, plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing; do not shear torch cut.
2. Fasten wall and joist metal framing members by welding, bolting, or screw fastening. Fasten suspended ceiling framing by screw and wire tie. Clinch fastening, or riveting of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate screws and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

K. Install framing members in one-piece lengths. Splice connections for tracks may be used only if indicated.

L. Install temporary bracing and supports to secure and support framing. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

M. Install insulation in framed walls and give particular consideration to framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work and areas that will receive pre-boarding prior to being concealed.

N. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer’s standard punched openings.

O. Install metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet along framing member and perpendicular to framing member. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

P. Coordinate erection of studs/joists with installation of service utilities to minimize discontinuity in framing. Align stud web openings.

Q. Provide double studs/joists at all openings. Provide 1 inch long by 1/8 inch welds at 16 inches on center on both sides of double framing.

R. Provide framed openings for all recessed components.

S. Install bracing at studs/joists to make rigid. Do not install cross-bracing at double stud walls and partitions unless acceptable to Architect to preserve acoustical quality of assembly.
T. Install interlocking bridging member through stud web openings at stud 7 feet 6 inches in length or greater.

3.4 Installing Suspension Systems

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

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. Splay hangers only where required to miss obstructions and to 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. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standard.

3. Secure wire hangers 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. Do not attach hangers to steel roof deck.

5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

8. Do not attach hangers to bottom chord of trusses or intermediate members.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Support members shall be provided as required at ceiling openings for access panels, recessed light fixtures, and air supply or exhaust. Support members shall be not less than 1-1/2-inch main runner channels and vertically installed suspension wires or straps shall be located to provide at least the minimum support specified herein for furring and wallboard attachment. Intermediate structural members not a part of the structural system, shall be provided for attachment or suspension of support members.

G. Light fixtures and air diffusers shall be supported directly from suspended ceiling runners. Wires shall be provided at appropriate locations to carry the weight of recessed or surface mounted light fixtures and air diffusers.

H. Ceiling control joints for expansion and contraction shall be located where indicated on Drawings. Intermediate blocking shall be installed where ceiling framing members change direction.

I. Install splay wires and compression struts as detailed and as required to prevent upward and sideward motion under seismic conditions, as required by code.
J. Suspension under Ducts: For hangers spaced at 4 to 5-1/2 foot centers, provide 6 gage hanger wires with minimum 2-inch runner channels spaced at maximum 48-inch centers. For greater spans, design system for live load of 10 pounds per square foot of area plus dead load and detail in shop drawings.

K. Provide framing for horizontal furring as shown and required. Conform to above requirements as applicable.

3.5 Installing Framed Assemblies

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction. Provide studs at spacings indicated, or if not indicated 16-inches on center. Provide studs using minimum gages specified herein unless heavier gages are indicated otherwise on the Drawings. Cut studs 1/2-inch short and secure to top track in manner that allows for deflection of structure above. Steel framing and furring members shall be installed in accordance with ASTM C 754 and as specified herein. Members shall be in alignment. Tracks shall be aligned accurately at the floor and ceiling and securely anchored.

C. Bolt or screw fasten framing and tracks to metal and concrete with bolts and expansion shields, sleeved “dryvins,” cinch anchors, screws and lead plugs, drilled and bolted steel shells, or other approved device. Concrete nails are not acceptable. Abutting lengths of track shall be securely anchored to a common structural element, butt-welded or spliced. Secure all tracks within 6-inches of ends and as indicated, or if not indicated, 24-inch centers maximum. Provide concrete anchors with a minimum 1-1/4-inch embedment.

D. The framing system shall provide for the installation and anchorage of the required sub-frames or finish frames for wall openings at doors, pass-through openings, and access panels. Partitions abutting continuous suspended ceilings shall be strengthened for rigidity at rough openings of more than 30-inches wide. Studs at openings shall be 16 gage minimum thickness and spot grouted at jamb anchor inserts. Double studs shall be fastened together with screws and secured to floor and overhead runners. Form heads and sills of openings with track sections screwed or bolted to jamb studs, unless otherwise shown.

E. Install tracks (runners) 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 penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

   a. Install two studs at each jamb, unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum ½-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. Install firestop track to maintain continuity of fire-resistance-rated assembly indicated.
5. Install sound-rated partition 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 not less than 2 studs at ends of arcs, place studs 6 inches on center.

7. Provide column and pilaster furring in overall dimensions indicated. Provide attachment clips and supports as necessary. Connect and support framing to structure within span limits.

F. 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 on center.

G. Z-Furring Members:
   1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches on center.
   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 on center.
   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.

H. 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.

3.6 Sound Insulated Walls and Partitions

A. Embed floor runner tracks in two beads of acoustical sealant or two strips of compressed tape seal. Install the top track in same manner for full-height insulated walls. Where wall ends abut concrete, masonry, or steel, set end studs in two beads of acoustical sealant or two tape seals and secure at 4-foot centers vertically. At irregularities in surfaces, provide additional layers of sealant or tape as required to obtain compression.

B. Embed floor runner tracks in two beads of acoustical sealant or two runs of compressed tape seal. Install the top track in same manner for full-height insulated walls.

3.7 Backing Plates and Anchorage

A. Install plates of lengths to span over at least three stud supports, equipped with two countersunk machine screws at each support except plates may be welded to supports 16 gage or heavier. Wall-mounted items requiring backing plates include but are not limited to items in this Section.

3.8 Framed Ceilings and Tunnel Construction

A. Where fire rated corridors are indicated or required, and where framed ceilings are shown, construct “tunnel” framing consisting of steel studs for walls and for ceilings.

B. Securely weld or screw attach flanges of horizontal studs to stud tracks for walls. Spacing of studs shall not exceed 16-inches for walls and for ceilings. Provide bridging in ceilings where width exceeds 8-feet.
C. The assembly shall be rigidly braced to structure above by means of diagonal braces or taut wires as applicable. Provide additional diagonal braces for ceilings wider than 8-feet.

3.9 Repairs and Protection

A. Prepare and repair damaged coatings on fabricated and installed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure that metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 22 16
SECTION 09 29 00 - Gypsum Board

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 07 21 00 “Insulation.”
3. Section 07 84 00 “Through-Penetration Firestop Systems.”
4. Section 07 92 00 “Sealants.”
5. Section 08 11 13 “Steel Doors and Frames.”
6. Section 09 22 16 “Non-Structural Metal Framing.”
7. Section 09 30 00 “Tile.”
8. Section 09 53 23 “Suspended Ceilings.”
9. Section 09 90 00 “Painting.”
10. Section 10 11 00 “Visual Display Units.”
11. Section 10 14 00 “Signage.”
12. Section 10 22 39 “Folding Panel Partitions.”
13. Section 10 26 23 “Impact-Resistant Wall Protection.”
14. Section 10 28 16 “Toilet and Bath Accessories.”
15. Section 10 44 00 “Fire-Protection Specialties.”

1.2 Submittals

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

B. Samples: For the following products:

1. Trim Accessories: Full-size sample in 12-inch-long length for each trim accessory indicated.
2. Textured Finishes: 12-inch by 12-inch for each gypsum board finish indicated and on same backing indicated for Work.

1.3 Quality Assurance

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Before gypsum board installation provide mockups of at least 8’ x 8’ in surface area to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of gypsum board texture, finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

D. Conduct pre-installation meeting to comply with requirements in Section 013100 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

E. Applicator of gypsum board products and finishes to have a minimum of 10 years experience with similar installations and applications.

F. Comply with Gypsum Association:

1. GA-201 Gypsum Board for Walls and Ceilings.
2. GA-216 recommended specifications for the Application and Finishing of Gypsum Panel Products.

G. Comply with USG Specification and Technical Bulletins No. SA-922, No. SA-923, and No. SA-924, as applicable for materials location, installation and condition of construction.

H. Coordinate gypsum board work with work specified in other Sections to properly locate framing members and to provide additional framing and backing as necessary for recessed and built-in components. Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board.

1.4 Storage and Handling

A. Comply with GA-801.
B. Delivery gypsum products and related materials in original packages bearing brand name and identification of manufacturer.

C. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Neatly stack panels flat off ground to prevent sagging.

D. Handle gypsum products to prevent damaging edges, ends, backs or faces.

1.5 Project Conditions

A. Comply with ASTM C 840 for environmental requirements or gypsum board manufacturer's written recommendations, whichever are more stringent. Provide for more expensive condition at no additional cost to Owner.

B. Do not install interior gypsum board products until installation areas are enclosed and weathertight.

C. Do not install gypsum board products that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

D. Do not install gypsum board products over wet or damp concrete or masonry surfaces or concrete which has cured for less than 28 days.

1.6 Coordination

A. Coordinate with mechanical, electrical and other trades in the location and installation of their work. Provide bridging, bracing and backing to support their work installed in or on sheathing construction.

B. Coordinate final location of necessary access panels.

C. Coordinate requirements for preboarding areas that will be covered by subsequent construction.

D. Coordinate compatibility of sealing compounds, high solids primer and skim coat materials with finish system requirements.

E. Contractor is aware of a condition known as critical lighting. This condition causes shadows that accentuate even the slightest surface variations. A base sealer will provide tooth for succeeding paint coatings but does not equalize smoothness or suction of surface. Any corrective action must be done by gypsum board finisher / installer prior to painting. Coordinate with paint installer to achieve desired results.

F. Sequence installation of gypsum sheathing board with installation and application of underlayments, exterior cladding and other finishes so that gypsum sheathing board is not exposed to weather for more than 1 month.
PART 2 - Products

2.1 General

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

B. For each type of product use products of a single manufacturer from a single source.

C. For corridor walls and high traffic areas provide high impact form of product.

D. Gypsum board, joint treatment and finishing materials shall be manufactured from asbestos-free materials.

2.2 Interior Gypsum Board

A. Complying with ASTM C 36 or ASTM C 1396, as applicable to type of gypsum board indicated and whichever is more stringent. Provide in thickness and types indicated.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. G-P Gypsum.
   c. PABCO Gypsum.
   d. USG Corporation.

B. Regular Type: Long Edges: Tapered.

C. Type X: Long Edges: Tapered.

D. Type C: Long Edges: Tapered. Thickness as required by fire-resistive-rated assembly indicated.

E. Flexible Type: Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness. Apply additional layers to flush surface with adjacent surfaces. Long Edges: Tapered. Thickness: 1/4-inch.

F. Ceiling Type: Manufactured with sag resistance greater than regular-type gypsum board. Long Edges: Tapered.

G. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board. Long Edges: Tapered.

H. High-Impact Type: Manufactured with Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance). Plastic-Film Thickness: 0.020 inch.

I. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces. Do not use green board. Long Edges: Tapered. Core: Type X.

2.3 Exterior Gypsum Sheathing

A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177. Subject to requirements, provide "Dens-Glass Gold" by G-P Gypsum, or approved equal. Core: As indicated.
2.4 Trim Accessories

A. Interior Trim: ASTM C 1047.

1. Galvanized steel sheet:
   a. Cornerbead.
   b. LC-Bead: J-shaped; exposed long flange receives joint compound.
   c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
   d. Control joint.
   e. Curved-Edge Cornerbead: With notched or flexible flanges.

   a. Reveals, Fry Reglet or approved equal size for depth of gypsum board.
      1) “F” reveal.
      2) “X” molding.
      3) Reveal channel screed: Size as indicated on Drawings.

2.5 Fasteners

A. Screws for Metal Framing 20 Gage and Lighter: ASTM C 954, corrosion-resistant self-tapping bugle-head spiral-threaded type, minimum 1-1/4” long except 1-3/4” for double layer walls, lengths to penetrate all supporting metal at least 3/8”. Furnish specially hardened type screws for supports heavier than 25 gage.

B. Screws for Metal Framing Heavier than 20 Gage: 1-1/4” bugle-head with S-12 point, with self embedding head specially designed for use with board. Fasteners shall be stainless steel or shall have non-corrosive finish.

C. Screws for Wood Substrate: ASTM C 646, USG Durock Flat Wafer Headscrews, Type W, steel self-drilling screws, low profile head, length in accordance with manufacturer’s recommendations and ML/SFA specifications.

D. Gypsum Sheathing Fasteners: Self-tapping steel drill screws 1-1/4” long, with organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 800 hours per ASTM B 117. Provide type S-12 bugle-head self-tapping steel drill screws complying with ASTM C 954 to attach sheathing to steel framing from 0.033- to 0.112-inch thick.

E. Nails are not acceptable.

2.6 Joint Treatment Materials

A. General: Comply with ASTM C 475.

B. Joint Tape:

1. Interior Gypsum Board: Paper.


Gypsum Board
09 29 00 - 5
C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Exterior Applications: Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. High Solids Primer: USG Sheetrock “First Coat,” or approved equal. Coordinate with finish materials to assure compatibility.

F. Skim Coat: USG “Sheetrock All Purpose Joint Compound,” or approved equal.

G. Acoustical Sealant: Comply with Section 07 29 00.

2.7 Texture Finishes

A. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.
   1. Subject to requirements, provide products by one of, or equal to, the following:
      a. G-P Gypsum; Georgia-Pacific Ceiling Textures/Vermiculite.
      b. USG Corporation; Sheetrock Wall and Ceiling Spray Texture (Aggregated).
   2. Texture: Light spatter.

B. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.
   1. Subject to requirements, provide products by one of, or equal to, the following:
      a. International Cellulose Corp.; SonaSpray “fc:”
      b. USG Corporation; USG Acoustical Plaster Finish.
   2. Application thickness: 1/2-inch.
   3. Fire-Test-Response Characteristics: Flame spread; less than 25, smoke developed; less than 50, when tested according to ASTM E 84.
   4. NRC: 0.55 according to ASTM C 423.

PART 3 - Execution

3.1 Examination

A. Examine areas and substrates, with installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance. Make a detailed inspection of areas and surfaces to be enclosed or covered by gypsum board and arrange for correction of defective workmanship or materials. Ascertain that other work enclosed by gypsum board has been inspected and approved before starting installation; otherwise, uncover as directed at no additional time or cost to Contract.
B. For areas to receive gypsum sheathing, field inspect and verify that all framing studs, blocking and
supporting materials are in place and ready for sheathing attachment prior to starting work. Coordinate
the exterior placement of electrical, mechanical and plumbing wall devices, accessories and access
panels, wall signage and other type wall construction with other trades before proceeding with the work
and during installation.

C. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

E. Proceeding with installation indicates acceptance of substrate conditions by Contractor.

3.2 General Application

A. Comply with ASTM C 840.

B. Perform all gypsum board installation and finishing according to gypsum board manufacturer’s written
instructions. Do not install gypsum board until building is weathertight. Conform to fire-rating
requirements, building code approvals, and requirements herein.

C. Maintain temperature between 55° F and 70° F within building during installation. Furnish ventilation to
eliminate excessive moisture.

D. Install joints, casings, trims, cornerbeads and other accessories in maximum lengths possible to minimize
laps and joints. Miter exposed corners.

E. 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.

F. 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.

G. 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.

H. Form control joints with space between edges of adjoining gypsum panels.

I. Cover both faces of support framing with gypsum panels in concealed spaces.

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.

J. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except
floors. Provide 1/4- to 1/2-inch-wide spaces at these locations, and trim edges with edge trim where
edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical
sealant. Hold bottom edge of gypsum board up 1/4-1/2 inch above finish floor.
K. Attach panels to metal framing so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

L. Apply preliminary layers of fire rated gypsum board to locations in fire rated construction that will be concealed by other construction.

M. At 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 C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

N. Install moisture and mold resistant gypsum board behind all sinks, fountains, water coolers and cabinetry containing sinks and plumbing.

O. Install screws so heads are below gypsum board surface without breaking surface paper or stripping the steel framing member around the screw. Space screws according to code requirements.

P. Accurately cut and fit the gypsum board at openings. At door and other openings, cut gypsum board to continue across area above opening head; do not cut gypsum board to both jambs and fill in area over openings with separate pieces. Make the dimension from end joints to jamb over head of an opening 6” minimum. Stagger joints on opposite side of partition.

Q. Use gypsum boards of maximum practical length to minimize end joints and properly support around cutouts and openings. Secure with screws.

R. Construct walls, soffits, roofs and ceilings in accordance with the requirements of the code for the time ratings indicated on the Drawings or otherwise required by the code.

S. At hallways, corridors, libraries and laboratories, installed abuse and impact resistant gypsum board.

T. Provide fiberglass mat gypsum panels in lieu of paper-faced gypsum panels.

3.3 Applying Interior Gypsum Board

A. Install interior gypsum board in locations indicated on Drawings.

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 horizontally (perpendicular to framing), with vertical joints centered on framing unless otherwise required by fire-resistance-rated assembly, and minimize end joints. Stagger abutting end joints not less than one framing member in alternate courses of panels. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger vertical joints on opposite sides of walls.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

4. Apply gypsum panels to supports with steel drill screws. Ceiling screws at 8” o.c. edge. Wall screws at 7” o.c. edge. Field screws 12” o.c.

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 1 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 horizontally (perpendicular to framing) with end 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-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.

D. Curved Surfaces:

1. Install panels horizontally perpendicular to supports and unbroken, to greatest 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 on center. Offset gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 16 inches on center.


3.4 Installing Trim Accessories

A. 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 and according to ASTM C 840, and approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated.

2. LC-Bead: Use at exposed panel edges.

3. U-Bead: Use at exposed panel edges.


3.5 Finishing Gypsum Board

A. Comply with Gypsum Association GA-214 and GA-232, finish panels to levels indicated on Drawings and according to ASTM C 840.

1. Level 1: Apply tape bedding compound and tape on joints in gypsum board.

2. Level 2:

   a. Apply joint compound and finishing compound over screw heads. Treat all inside corners with joint compound, tape, and finishing compound. Treat outside corners with cornerbeads and finishing compound.

   b. Provide metal casing beads at all edges of gypsum board which abut ceiling, wall, or column finish, and elsewhere as required, such as openings, offsets, etc. Make all exposed joints, trims, and attachments non-apparent following application of paint or other finishes; if the joints and fasteners are apparent, correct defects as directed with no additional cost or time to Contract.
3. **Level 3:**
   a. Apply joint compound and finishing compound over screw heads. Treat all inside corners with joint compound, tape, and finishing compound. Treat outside corners with cornerbeads and finishing compound.
   b. Provide metal casing beads at all edges of gypsum board which abut ceiling, wall, or column finish, and elsewhere as required, such as openings, offsets, etc. Make all exposed joints, trims, and attachments non-apparent following application of paint or other finishes; if the joints and fasteners are apparent, correct defects as directed with no additional cost or time to Contract.
   c. Seal the raw edges of plumbing openings and of boards that have been cut to fit with joint compound brushed on.
   d. When entire installation is completed, and prior to installation of finish materials by other trades; correct and repair broken, dented, scratched, or damaged gypsum board.
   e. Spray apply one coat of high solids primer over entire surface.
4. **Levels 4 and 5:**
   a. Apply joint compound and finishing compound over screw heads. Treat all inside corners with joint compound, tape, and finishing compound. Treat outside corners with cornerbeads and finishing compound.
   b. Provide metal casing beads at all edges of gypsum board which abut ceiling, wall, or column finish, and elsewhere as required, such as openings, offsets, etc. Make all exposed joints, trims, and attachments non-apparent following application of paint or other finishes; if the joints and fasteners are apparent, correct defects as directed with no additional cost or time to Contract.
   c. Seal the raw edges of plumbing openings and of boards that have been cut to fit with joint compound brushed on.
   d. When entire installation is completed, and prior to installation of finish materials by other trades; correct and repair broken, dented, scratched, or damaged gypsum board.
5. **Level 4:** Spray apply one coat of high solids primer over entire surface.
6. **Level 5:** Apply one coat of skim coat over entire surface, followed by one spray applied coat of high solids primer over entire surface.
7. **Textured Surfaces:** Spray apply one coat of high solids primer to entire surface prior to texture application.
8. Levels of Gypsum Board Finish:

<table>
<thead>
<tr>
<th>Level</th>
<th>Joints</th>
<th>Interior Angles</th>
<th>Accessories</th>
<th>Fasteners</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>#0</td>
<td>Tape set in joint compound.</td>
<td>Tape set in joint compound.</td>
<td>No taping, finishing or accessories required</td>
<td>Tool marks and ridges acceptable. Surface free of excessive joint compound.</td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.</td>
<td>Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.</td>
<td>Shall be covered by one separate coat of joint compound</td>
<td>Shall be covered by one separate coat of joint compound</td>
<td>Surface shall be free of excessive joint compound. Tool marks and ridges acceptable. Joint compound applies over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.</td>
</tr>
<tr>
<td>#2</td>
<td>Tapes as in level #2, then covered with one separate coat of joint compound.</td>
<td>Tapes as in level #2, then covered with one separate coat of joint compound.</td>
<td>Shall be covered by two separate coats of joint compound</td>
<td>Shall be covered by two separate coats of joint compound</td>
<td>Joint compound shall be smooth and free of tool marks and ridges.</td>
</tr>
<tr>
<td>#3</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>Joint compound shall be smooth and free of tool marks and ridges.</td>
</tr>
<tr>
<td>#4</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>Joint compound shall be smooth and free of tool marks and ridges.</td>
</tr>
<tr>
<td>#5</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Taped as in level #2, then covered with two separate coats of joint compound.</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>Shall be covered by three separate coats of joint compound</td>
<td>A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.</td>
</tr>
</tbody>
</table>

B. 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.

C. Prefill open joints and damaged surface areas.

D. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

E. Take care that sanding operations do not raise paper surfaces of gypsum board.
3.6 Applying Texture Finishes

A. Prepare and apply primer to gypsum panels receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. 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 recommendations.

3.7 Protection

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

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 09 29 00
SECTION 09 30 00 - Tile

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 07 92 00 “Sealants.”
   2. Section 09 29 00 “Gypsum Board.”
   3. Section 10 28 16 “Toilet and Bath Accessories.”

1.2 Definitions

A. Dimension Stone Tile: Modular stone units less than 3/4 inch thick.

B. Polished Finish: Smooth finish that produces sharp, mirrorlike reflections. Reflected images of overhead fluorescent tubes have straight lines without visible distortion when viewed at arm’s length.

C. Honed Finish: Smooth, non-reflective finish similar to that produced by grinding with a 400- to 1200-grit abrasive; with a gap not exceed 0.005 inch, when faces are tested for flatness with a 24 inch straightedge.

D. Sand-Rubbed Finish: Uniform, fine-textured surface similar to that produced by grinding with a 40-grit abrasive; with a gap not exceeding 1/32 inch, when faces are tested for flatness with a 24 inch straightedge.

E. Thermal Finish: Uniform coarse-texture surface produced by thermal shock; with a gap not exceeding 3/16 inch, when faces are tested for flatness with a 24 inch straightedge.

F. Natural-Cleft Finish: Uneven surface produced by splitting stone along a natural cleavage plane; without visible tool marks and with a gap not exceeding 3/16 inch, when faces are tested for flatness with a 24 inch straightedge.

1.3 Performance Requirements

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

   1. Level Surfaces: Minimum 0.6.
   2. Step Treads: Minimum 0.6.
   3. Ramp Surfaces: Minimum 0.8.

1.4 Regulatory Requirements

A. All tile flooring shall be stable, firm, and slip resistant. Comply with CBC Section 11B-302.1. Acceptable demonstration of slip resistance; minimum coefficient of friction 0.6 per ASTM C 1028.
1.5 Submittals

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

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Stone tile color range samples consisting of at least 4 (four) full-size units of each type of stone tile, exhibiting extremes of the full range of color and other visual characteristics expected. Range samples establish the standard by which individual tiles will be judged.
3. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 12 inches square and mounted on rigid panel. Use grout of type and color intended for completed work.
4. Full-size units of each type of trim and accessory for each color and finish required.
5. Stone thresholds in 6 inch lengths.
6. Metal edge strips in 6 inch lengths.
7. Grout Samples: Samples of manufacturer’s full range of grout colors.
8. Tile and Grout: Submit plywood panels four tiles by four tiles in size with each color of preliminary floor and wall tile selections with joints grouted with preliminary grout selection. Final tile and grout selections will be made from these samples.

D. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and installer.

1.6 Quality Assurance

A. Comply with the following:

   c. A137.1 – Standard Specifications for Ceramic Tile.
   d. A118.9 – Specification for Cementitious Backer Units.

B. Provide products from a firm experienced in supplying products similar to those specified for the project and with a record of successful in-service performance.

C. Obtain all tile of same type, color and finish from one source or producer. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

D. Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

E. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:

1. Stone thresholds.
Tile

2. Waterproofing.
4. Cementitious backer units.
5. Metal edge strips.

F. Provide mockups of at least 8’ x 4’ in surface area to demonstrate aesthetic effects and set quality standards for materials and execution. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of tile, finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:

   a. Inside and outside corners.
   b. Window openings.
   c. Door openings.
   d. Flashings and underlayments.
   e. Transitions to other finish materials.
   f. Sealant joints.
   g. Sheathing, framing, lathing, mortar beds and substrates.
   h. Coving.
   i. Tile patterns.
   j. Grouting.
   k. Floor drain.
   l. Recessed accessory.
   m. Top of wainscot.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.
3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.
4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.
5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.
6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

G. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

H. Coordinate with flooring requirements for elevators.

1.7 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 requirement in ANSI A137.1 for labeling sealed 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 avoided.

D. Store liquid latexes in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 Project Conditions

A. Do not install tile mortar and grout until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

B. Where waterproofing or thinset tile is installed directly to cementitious substrates test for moisture content and pH levels and provide written test results indicating that moisture content of substrate is within applied material manufacturer’s recommendations for application.

C. Where tile or tile waterproofing is installed directly to cementitious substrates that were cured using liquid applied curing compounds test for compatibility with curing compounds and provide written results of compatibility testing.

D. Do not install mortar, set or grout tile when inclement weather conditions are expected within 48 hours after work is completed unless properly protected.

1.9 Sequencing and Scheduling

A. Sequence tile installation with other work to minimize possibility of damage and soiling during remainder of construction period.

B. Install tile and accessories only after other finishing operations, including painting, have been completed.

1.10 Extra Materials

A. Prior to Substantial Completion review, deliver to Owner additional tile and trim shapes of each type, color, pattern, and size used in work, for Owner’s use in replacement and maintenance.

B. Provide a minimum of 1 percent of field tile and 5 percent of trim and shapes.

C. Pack extra stock in undamaged original packing cartons, with additional protective materials added inside to prevent damage, with contents clearly labeled with project name, project identification number, supplier’s name, address and telephone number, and product identification.

PART 2 - Products

2.1 Manufacturers

A. The following requirements apply for product selection: Subject to requirements, provide products by one of, or equal to, the manufacturers listed.
2.2 Products, General

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.


C. Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics; provide specific products or materials as selected by Architect from manufacturer’s full range.

D. For tile exhibiting color variations within ranges selected during sample submittals, 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.

E. 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 that will contact grout and mortar.

F. Provide stone with an abrasion resistance value, where indicated, of not less than 10, as determined per ASTM C 1353 or ASTM C 241.

G. Provide stone products that are free of defects impairing their function and aesthetic value for use indicated, including cracks, seams, starts, chips and abrasions.

H. For stone varieties with a directional pattern, provide tile with pattern randomly oriented at various angles to sides of tiles.

I. Where two or more stone tile product types listed in the paragraphs below are identical except for size or finish, provide same variety from same source for each type.

2.3 Tile Products

A. Manufacturers:

   1. American Olean; Div. of Dal-Tile International Corp.
   2. Daltile; Div. of Dal-Tile International Inc.
   3. Quarry Tile Company.

B. See Finish and Material Legend, Sheet 9.01 and 9.02 for tile type, color and size.

C. Glazed Wall Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide manufacturer's standard shapes:

   1. Base Glazed Wall Tile shall be Self-Coved. Provide coordinating trim for Single Bullnose; Cove Base; Cove Base Inside Corner and Cove Base Outside Corner.

D. Ceramic Mosaic Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide manufacturer's standard shapes:

   1. Base Ceramic Mosaic Wall Tile shall be Self-Coved. Provide coordinating trim for Single Bullnose; Cove Base; Cove Base Inside Corner and Cove Base Outside Corner.
E. Quarry Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide manufacturer's standard shapes:

1. Base Glazed Wall Tile shall be Self-Coved. Provide coordinating trim for Single Bullnose; Cove Base; Cove Base Inside Corner and Cove Base Outside Corner.

F. Provide glazed vitreous china accessories of type and size indicated, in color and finish to match adjoining wall tile, and intended for installing by same method as adjoining wall tile.

1. One soap holder for each shower and tub indicated.
2. One paper holder at each water closet.

2.4 Thresholds

A. Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes. Bevel edges at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch maximum or less above finish surface of tile, and finish bevel to match face of threshold.

B. Granite Thresholds: ASTM C 615, with honed finish. Uniform, medium-grained, white stone without veining.

C. Marble Thresholds: ASTM C 503 with a minimum abrasion resistance of 10 per ASTM C 1353 or ASTM C 241 and with honed finish. Uniform, fine- to medium-grained white stone with gray veining.

2.5 Waterproofing and Crack-Suppression Membranes

A. Provide unreinforced, fluid-applied liquid-latex rubber with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as waterproofing. Custom Building Products; LevelQuick Waterproofing and Anti-Fracture Membrane, or approved equal.

2.6 Setting and Grouting Materials

A. Manufacturers:

2. Custom Building Products.
3. Laticrete International Inc.
4. MAPEI Corporation.

B. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.1 A and as specified below:

1. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 16 gage; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
3. Latex Additive: Acrylic resin 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.
4. Mortar Sand: ASTM C 144, at least 4% passing No. 100 sieve.
5. Water: From domestic potable source.

C. Latex-Portland Cement Mortar (Thinset):
1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at project site. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

D. Polymer-Modified Tile Grout:
   1. Provide polymer type ethylene vinyl acetate grout complying with ANSI A118.7, in dry, redispersible form, prepackaged with other dry ingredients. Custom building products Polyblend or approved equal. Allow for custom color.
      a. Unsanded grout mixture for glazed wall tile and other joints 1/8 inch and narrower.
      b. Sanded grout mixture for joints 1/8 inch and wider.

2. Joint Sand: Same as mortar sand except all passing the No. 30 sieve.

2.7 Cementitious Tile Backer Board
   A. Provide cementitious backer board complying with ANSI A118.9 in maximum lengths available to minimize end-to-end butt joints.
      1. Thickness: As indicated.
      2. Width: Manufacturer’s standard width, but not less than 32 inches.
      3. Custom Building Products: Wonderboard, or approved equal.

   B. Provide non-corroding self-tapping hi-lo bugle head screws in sufficient size and length to fasten into studs as recommended by backer board manufacturer. ASTM C 646 type S.

   C. Provide joint tape 2 inch wide for tile, 10 x 10 glass mesh tape reinforced fabric, balanced, alkali resistant, open-weave, glass fiber fabric, made from continuous multi-end strands with tensile strength of not less than 120 lbs. and 140 lbs. in warp and fill directions, respectively, per ASTM D 1682 and complying with ASTM D 578, with a minimum weight of 4.3 oz/sq. yd.

   D. Provide setting-type joint compound as recommended by the tile and backer-board manufacturer for finish tile work.

2.8 Miscellaneous Materials
   A. Provide trowelable latex-modified Portland cement-based underlayments and patching compounds recommended in writing by manufacturer of tile-setting materials for installations indicated.

   B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.

   C. Provide a neutral tile cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically recommended in writing for materials and installations indicated by tile and grout manufacturers.

   D. Provide manufacturer’s standard silicone grout product for sealing grout joints that does not change color or appearance of grout.

   E. Sealants: Comply with Section 07 92 00 “Sealants.”

   F. Self-adhered Flashings and Underlayments: As specified in Section 07 65 00.
2.9 **Mixing Mortars and Grout**

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers’ written instructions.

B. Add materials, water, and additives in accurate proportions.

C. 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.

D. Machine mix mortar after first dry mixing materials. Mix all mortar not less than 5 minutes after water is first added. Accurately measure materials using calibrated measuring boxes; shovel measurement is not permitted. Discard mortar that is not placed and compacted before initial set is reached. Measure all materials by volume.

E. For Exterior and Interior Wall Tile: Quantity ranging from 1-part Portland cement, 1/2-part hydrated lime, and 5-parts damp sand to 1-part Portland cement, 1-part hydrated lime, and 7-parts damp sand.

F. For Floor Tile: Quantity of 1-part Portland cement, 1/10-part hydrated lime, and 6-parts damp sand, mixed to consistency and workability that allows maximum compaction during tamping of mortar bed.

**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 installed tile. Before tile work begins:

1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
2. 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 before installing tile.
3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
4. For areas to receive thinset tile check substrate to ensure that substrates are level or uniformly sloped as indicated.
5. Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive backing board.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation indicates acceptance of substrate conditions by contractor.

3.2 **Preparation**

A. Remove surface applied finishes, adhesives, coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials. Mechanically sand and scarify the substrate to completely remove all paint, loosely bonded topping, loose particles and construction debris. Neutralize any trace of strong acid or alkali.

B. Verify substrates for tile floors installed with thinset mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards. If necessary to bring surfaces into
compliance, fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer. Remove protrusions, bumps, and ridges by sanding or grinding.

C. For tile exhibiting color variations within ranges selected during sample submittals, 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, return to manufacturer for blending.

D. Condition spaces for application of crack isolation and waterproofing membranes to temperature range required by membrane manufacturer.

E. Turn off all forced ventilation and radiant heating systems and protect work against drafts during tile installation and for a period of at least 72 hours after completion. Use indirect auxiliary heaters to maintain the temperatures in the area at the recommended workable level. Vent temporary heat to exterior to prevent damage to tile work from carbon dioxide build-up.

F. All concrete substrates shall be at least 28 days old, completely cured and free of hydrostatic conditions, and/or moisture problems. New concrete surfaces for dry-set mortar, medium-bed mortar or thick-bed mortar installations shall be wood floated or broom finished. Concrete walls should be bush-hammered or heavily sandblasted. Coordinate with concrete work to assure proper finish.

G. Over excessively dry porous concrete, keep the concrete substrate continuously moist for at least 24 hours before work begins when using dry-set mortars or medium-bed mortars. Scrub slab with a neat Portland cement slurry just before placing setting mortar. Remove all excess water or standing water allowing the surface to become almost dry before installing tile.

H. Soak mortar bed set glazed tile in clean water according to Reference Standard. Dampen other tile according to Reference Standards or tile manufacturer’s instructions.

I. Accurately set temporary screeds to control the finish plane of mortar bed set tile and remove as soon as setting bed is sufficiently hardened. Fill void spaces from screeds with same mortar.

3.3 Installation, General

A. Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

B. Comply with TCNA’s "Handbook for Ceramic Tile Installation" installation methods indicated in ceramic tile installation schedules.

C. Lay out tile patterns by marking joint lines on substrates to verify joint placement at edges, corners, doors, and other critical elements. Notify Architect seven days in advance of dates and times when layout will be done. Obtain Architect’s approval of layout before starting tile installation.

D. Lay out tiles on substrates or on an adjacent surface to establish placement of individual tiles for balance of color and pattern variations.

1. Notify Architect seven days in advance of dates and times when layout will be done.

2. Architect may relocate specified stones with other stones of same type and will determine final location of each tile within indicated patterns.
3. Identify each tile with a temporary number marked on face of tile that corresponds with an identical number marked on a layout drawing, and obtain Architect’s approval before starting tile installation.

E. Extend tile work into recesses, under and 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.

F. Isolate setting beds and tile from surrounding walls with compressible closed cell material.

G. 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 smooth edged joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile. Drill holes for small pipes, do not split or cut tiles.

H. Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work to minimize tile cutting and to maximize whole tiles in visual areas. Provide uniform joint widths. 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.

I. Match tiles within each space by selecting tiles to achieve uniformity of color and pattern. Reject or relocate tiles that do not match color and pattern of adjacent tiles.

J. Mix tiles to achieve a uniformly random distribution of color shadings and patterns.

K. Lay out tile wainscots to next full tile beyond dimensions indicated.

L. At showers, tubs, and where indicated, install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 Backerboard Application

A. All framing should comply with local building code requirements and be rigid. Coordinate with framing work to assure satisfactory conditions. Install backerboard according to GA-216 and ASTM C 840. Do not install backerboard until building is weathertight. Maintain ambient temperature between 55° F and 75° F.

B. Fasten panels every 6 to 8 inches on center throughout the field and within 1/2 inch to 2 inches from the edge using 1-1/4 inch concrete backerboard screws. Set screws to bear tightly to surface without cutting into boards.

C. Edges of backerboard parallel to framing should be continuously supported. Leave a 1/8 inch gap between boards at all joints and corners. Stagger board joints with those of adjacent rows. Install board horizontally across and perpendicular to studs.

1. Where open mesh wrapped edges meet, fill the gap completely with thinset mortar.
2. On all other joints and corners, Prefill the gap with thinset mortar, and then embed 2 inch wide alkali-resistant mesh tape and smooth.

D. Accurately cut and fit the backerboard at openings. At door and other openings, cut backerboard to continue across area above opening head; do not cut backerboard to both jambs and fill in area over openings with separate pieces. Make the dimension form the joint over head of an opening to jamb of openings 6 inch minimum. Stagger joints on opposite side of partition. Treat all cut edges, ends and penetrations with sealants.
E. Place backerboard horizontally with the long dimension across the studs or in one piece vertical heights, vertical joints centered on supports and staggered on walls so as not to occur on opposite sides of the same stud. Use maximum lengths possible to minimize number of joints. Stagger end joints and edge joints. Secure to each stud and track with screws keeping screws 3/8 inch from edges. Where required to accommodate deflection, or where required by building code, omit screws on top track.

F. Locate control and expansion joints at same locations as substrate and at locations of finish materials. Where expansion joints are not indicated, provide joints at each 30 lineal feet of continuous wall.

G. Apply reinforcing fabric glass mesh joint tape over joints. Embed tape in setting material indicated for wet use applications and the specified tile finishes. Allow joints to dry prior to installing tile system.

3.5 Waterproofing and Crack-Suppression Membrane Installation

A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.

B. Install membrane to comply with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate. Test continuity of horizontal membrane with 24 hour flood test. Test continuity of vertical membranes with spray test.

C. Do not install tile over membrane until membrane has cured and been tested to determine that it is watertight.

D. Rout out and fill cracks 1/16 inch and larger with membrane. Embed 6 inch wide fiberglass tape into membrane over cracks.

E. Apply membrane using tools and methods according to manufacturer’s instructions and recommendations. Dried coating thickness shall be as recommended by manufacturer and sufficient to prevent substrate cracks from continuing up through tile. After key-in or burn-in coat to fill all surface voids. Assure membrane is fully and completely adhered to all surfaces. Immediately apply additional membrane material to form smooth, continuous membrane. Ensure that membrane has no voids, bubbles or breaks.

F. Heavily pre-coat all edges and corners. Where horizontal and vertical surfaces meet, flash and reinforce joint.

1. Apply membrane and embed 6 inch wide fiberglass tape over juncture.
2. Membrane shall extend 2 inches to 3 inches beyond fiberglass tape or to expected flood point.
3. Overlap fiberglass mesh 3 inches at all seams and at inside and outside corners where walls intersect.

G. Terminate membrane at floor drains according to membrane manufacturer’s details and recommendations.

H. Allow membrane to cure, in accordance with manufacturer’s instructions, prior to starting installation of tile.

3.6 Floor Tile Installation

A. Install floor tile to comply with requirements of TCNA installation methods indicated on Drawings and ANSI A108 Series of tile installation standards.

B. Joint Widths: Install tile on floors with the following joint widths:
2. Quarry Tile: 1/4 inch.

C. Provide expansion joints in compliance with TCNA Handbook Method EJ171.
   1. Provide expansion joints throughout where tile work abuts restraining surfaces.
   2. Provide expansion joints directly over expansion and control joints in slab on grade
   3. Provide expansion joints as indicated, or at 20 feet maximum on center each way if not indicated.

D. Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.

E. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

3.7 Wall Tile Installation
A. Install types of tile designated for wall installations to comply with requirements of TCNA installation methods indicated on Drawings and ANSI setting-bed standards.

B. Install metal lath and scratch coat for walls to comply with ANSI A108.1 A, Section 4.1 and Section 09 24 00 “Exterior Plaster.”

C. Joint Widths: Install tile on walls with the following joint widths:
   2. Glazed Wall Tile: 1/16 inch.

3.8 Stone Tile Installation Tolerances
A. Variation from Plumb: For vertical joints, external corners, and other conspicuous lines, do not exceed 1/8 inch in 8 feet.

B. Variation at Level: For horizontal joints and other conspicuous lines, do not exceed 1/4 inch in 20 feet.

C. Variation in Surface Plane of Flooring: Do not exceed 1/8 inch in 10 feet from level or slope indicated when tested with a 10 foot straightedge.

D. Variation in Plane between Adjacent Units (Lipping): Do not exceed the following differences between faces of adjacent units as measured from a straightedge parallel to tiled surface:
   1. Units with Polished Faces: 1/64 inch.
   2. Units with Honed Faces: 1/64 inch.
   4. Units with Thermal-Finished Faces: Depth of thermal finish or 3/16 inch, whichever is less.
   5. Units with Natural-Cleft Faces: Depth of natural-cleft finish or 3/16 inch, whichever is less.

E. Variation in Joint Width: Do not vary joint thickness more than 1/16 inch or one-fourth of nominal joint width, whichever is less.

F. Hand-Tight Joints: Do not exceed 1/64 inch.
3.9 Grouting

A. Grout tile to comply with ANSI A108.10.

1. Do not begin grouting until tiles are firmly set and specified minimum curing time has elapsed.
2. Remove spacers, ropes, glue, and similar foreign matter prior to grouting.
3. When using proprietary grout, comply with manufacturer’s instructions and recommendations unless otherwise more stringent requirements are specified.
4. Force maximum amount of approved grout into joints in accordance with pertinent recommendations contained in ANSI A108.10.
5. Fill joints of cushion edge tile to depth of cushion; fill joints of square edge tile flush with tile surface.
6. Fill all gaps and skips.
7. Do not permit mortar or mounting mesh to show through grouted joints.
8. Provide hard finished grout which is uniform in color, smooth, and without voids, pin holes, or low spots.
9. Leave tile clean.
10. Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer on tile faces by wiping with soft cloth.

3.10 Joint Sealant

A. Apply sealant after tile is grouted, grout is cured and tile field is thoroughly clean and dry. Comply with Section 07 92 00 “Sealants.”

1. Seal between tile and all penetrating elements.
2. Seal perimeter of tile field where tile base is not provided.
3. Seal around plumbing fixtures.
4. Seal around plumbing piping penetrations.
5. Seal around door frames and other items set in wall.

3.11 Cleaning and Protecting

A. On completion of placement, grouting and curing, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove latex-Portland cement grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. 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. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
4. Remove and replace material that is stained or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
5. Do not use acid or acid based cleaners to clean tile and grout.

B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with heavy kraft paper covering with edges fully taped during construction period to prevent staining, damage, and wear.
C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces. Apply sealer to cleaned stone tile flooring, according to sealer manufacturer’s written instructions.

END OF SECTION 09 30 00
SECTION 09 53 23 – Suspended Ceilings

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 12 00 “Structural Steel.”
2. Section 05 40 00 “Cold-Formed Metal Framing.”
3. Section 07 84 00 “Through-Penetration Firestop Systems.”
4. Section 07 92 00 “Sealants.”
5. Section 09 22 16 “Non-Structural Metal Framing.”
6. Section 09 29 00 “Gypsum Board.”
7. Section 09 90 00 “Painting.”
8. Division 23 Heating, Ventilating, and Air Conditioning Sections.
9. Division 26 Electrical Sections.
10. Division 27 Communications Sections.

1.2 Submittals

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

B. Coordination Drawings: Reflected ceiling plans, 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. Ceiling suspension system members.
2. Method of attaching hangers to building structure. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
3. Size and location of initial access modules for tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Minimum Drawing Scale: 1/8 inch = 1 foot.

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

1. Suspended Tile: 12 inch x 12 inch samples of each type, color, pattern, and texture.
2. Concealed Suspension System Members: 12-inch-long sample of each type.
3. Exposed Moldings and Trim: Set of 12-inch-long samples of each type and color.

1.3 Quality Assurance

A. Source Limitations:

1. Suspended Ceiling Tile: Obtain each type of style and finish through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.
B. Provide materials from a manufacturer with a minimum of 10 years documented experience in the manufacturing and distribution of ceiling systems similar to those specified.

C. Provide installer with 5 years minimum documented experience installing and handling ceiling systems similar to those specified.

D. Fire-Test-Response Characteristics: Provide suspended tile ceilings that comply with the following requirements:

1. Fire-Resistance Characteristics: Where indicated, provide suspended tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

2. Surface-Burning Characteristics: Provide suspended tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84: Smoke- Developed Index: 450 or less.

E. Seismic Standard: Provide suspended tile ceilings designed and installed to withstand the effects of earthquake motions according to California Building Code and Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.

F. Regulatory Requirements, Seismic Design: Conform to California Building Code (CBC) requirements and requirements of the Division of the State Architect (DSA) for seismic-resistant design and installation of ceiling suspension system, including DSA Interpretation of Regulations IR M-3.

G. Regulatory Requirements, Fire Characteristics: California Building Code (CBC) for class as indicated below, as determined by an independent testing laboratory acceptable to authorities having jurisdiction.

1. Exit Ways: Maximum Flame Spread Class I.
   a. Flame Spread: ASTM E 84, 25 or less.
   b. Smoke Density: ASTM E 662, not more than 450.

2. Rooms and Other Areas: Maximum Flame Spread Class II.
   a. Flame Spread: ASTM E 84, not more than 75.
   b. Smoke Density: ASTM E 662, not more than 450.

H. Finished ceilings shall be level within a tolerance of 1/8-inch in 12-feet in any direction, non-accumulative.

I. Variation from plumb of grid members caused by eccentric loads, two degrees maximum.

J. Before beginning actual work, install mockups of at least 8’ x 8’ in surface area to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of suspended ceiling and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:

   a. Inside and outside corners.
   b. Light fixtures.
   c. Air registers and returns.
   d. Equipment penetrations.
   e. Transitions to other finish materials.
f. Interface with wall types.
g. Condition at building joints.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.
3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.
4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.
5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.
6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

K. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.4 Delivery, Storage, and Handling

A. Deliver tiles, suspension system components, and accessories to project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Upon receipt inspect materials and promptly remove and replace defective or damaged materials.

C. Coordinate delivery times with scheduled installation dates. Storage time of materials at the job site should be as short as possible. Excess humidity during storage can cause expansion of material and possible warp, sag, or poor fit after installation. Chemical changes in the mat and/or coatings can be aggravated by excess humidity and cause discoloration during storage, even in unopened cartons. Cartons should be removed from pallets and stringers to prevent distortion of material.

D. Before installing tiles, permit them to reach room temperature and stabilized moisture content.

E. Handle tiles carefully to avoid chipping edges or damaging units in any way.

1.5 Project Conditions

A. Do not install suspended tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, dust generating work is complete, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use. Maintain interior temperature between 60° F and 85° F and relative humidity of 70 percent or less for 7 days prior to installation of ceilings, and continuously thereafter, until final acceptance.

B. Verify the locations of various electrical and mechanical fixtures and equipment items installed above ceilings and the required access to dampers, valves, controls, and similar items. Coordinate locations of
hanger wires and ceiling installations with all such fixtures and equipment to obtain neat symmetrical result as shown on reflected ceiling plans.

1.6 Coordination

A. Coordinate layout and installation of tiles 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.

1.7 Extra Materials

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Suspended Ceiling Units: Full-size tiles equal to 1.0 percent of quantity installed.
2. Suspension System Components: Quantity of each concealed grid and exposed component equal to 1.0 percent of quantity installed.

1.8 Warranty

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace acoustical panels that will fail with the warranty period. Failures include, but are not limited to:

1. Acoustical Panels: Sagging and warping.
2. Grid System: Rusting and manufacturer’s defects.

B. Warranty Period Standard:

1. Acoustical Panels: One year.
2. Grid: Ten years.

PART 2 - Products

2.1 Ceiling Tiles, General

A. Provide tiles in configurations indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

B. Match appearance characteristics indicated for each product type. Where appearance characteristics of tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

C. Provide ceiling tiles treated with manufacturer's standard antimicrobial formulation throughout tile, that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 Acoustic Tiles for Suspended Ceiling

A. Subject to requirements, provide products as indicated on the Drawings.
B. Color: As selected from manufacturer’s full range.
C. LR: Not less than 0.65.
D. NRC: Not less than 0.50.
E. Edge/Joint Detail: Square, kerfed and rabbeted, or tongue and grooved, or butt.
F. Thickness: 5/8 inch.
G. Modular Size: As indicated on Drawings.
H. Antimicrobial Treatment: Broad spectrum fungicide and bactericide.
I. Flame Spread Rating: Furnish incombustible acoustical units with flame spread rating indicated per ASTM E 84 Tunnel Test.

2.3 Gypsum Panels
A. Subject to requirements, provide National Gypsum Gridstone Gypsum ceiling panels or approved equal.
B. Provide panels 5/8 inch thick gypsum panel sealed on front and back with 2 mil thick rigid vinyl laminate. End edges are to be sealed with coating that encapsulates panel, providing a completely sealed panel. ASTM C 960.
C. Size: As indicated on Drawings.
D. Surface Burning Characteristics: Flame spread 5, smoke developed 0, Class A per ASTM E 84 light reflectance 1.

2.4 Metal Suspension Systems, General
A. Provide manufacturer's metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
C. Size attachment devices for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung." Comply with seismic design requirements. Provide cast-in-place anchors in concrete of carbon-steel zinc plated components to comply with ASTM B 6533, Class Fe/Zn 5 for Class SC 1 service condition.
D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
   2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch-diameter wire.
E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
F. Angle Hangers: Angles with legs not less than width indicated; formed with 0.04-inch-thick, galvanized steel sheet complying with ASTM A 653, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.

H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure tiles in-place.

2.5 Metal Suspension System for Tile Ceiling

A. Subject to requirements, provide products as indicated on the Drawings.

B. Direct-Hung, Double-Web, Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653, G30 coating designation.

1. Structural Classification: Heavy-duty system bearing UL label, deflection limit 1/360.
2. Access: Upward and end pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining suspended tiles. Initial Access Opening: In each module.
3. Factory finish exposed grid surfaces with baked low-luster enamel of color to match acoustical units.

PART 3 - Execution

3.1 Examination

A. Examine substrates, areas, and conditions, including structural framing and substrates to which suspended tile ceilings attach or abut, with installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of suspended tile ceilings. Verify that work above ceiling is complete and installed in manner that will not affect layout and installation of ceiling panels.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation indicates acceptance of substrate conditions by contractor.

3.2 Preparation

A. Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

B. Measure each ceiling area and establish layout of tiles to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures. Comply with layout shown on reflected ceiling plans.

3.3 Installation, Suspended Tile Ceilings

A. Install suspended tile ceilings to comply with ASTM C 636 and seismic design requirements per California Building Code.

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. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

4. 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.

5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

6. 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 will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

7. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

8. 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.

9. Do not attach hangers to steel deck tabs.

10. Do not attach hangers to steel roof deck. Attach hangers to structural members.

11. Space hangers not more than 48 inches on center along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

12. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

13. Conform to the UL Design Approval for the grid.

14. Space hanger wires at maximum 48 inch centers along main tees and connect to structure above as shown in approved submittals.

15. Equip hanger wires with vibration isolators where located below and within 10-feet of rooms and spaces containing or supporting mechanical equipment.

16. Space main tees at maximum 48 inch centers and install cross tees to complete grid. Lock suspension members together to form joints that resist 100 pounds tension and compression. Cope bottom flanges of tees, where exposed, for flush tight connections with metal trims at vertical surfaces. All attachments shall be concealed. Pop rivets or other exposed fasteners will not be acceptable.

17. For exposed grid acoustical units install units with edges bearing on tees and secured with hold-down clips. Closely fit units to ceiling penetrations.

18. Provide painted metal trims and moldings at walls and other vertical surfaces and penetrations, joints closely butted, mitered at angles, and flush. Lapped joints are not permitted. All attachments shall be concealed. Pop rivets or other exposed fasteners will not be acceptable.

19. Provide framing, trims, and other finish materials for ceiling offsets as required to properly finish at offsets or ceiling breaks, types as indicated, directed, and approved.

20. After lighting fixtures and lenses are in place, adjust to level within tolerances specified above. After leveling is complete, neatly twist ends of hanger wires around suspended sections and cut off loose ends.

21. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
22. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Support fixture loads by supplementary hangers located within 6 inches of each corner or support components independently with hanger wires at each corner of component.

23. Do not eccentrically load system, or produce rotation of runners.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of suspended tile ceiling area and where necessary to conceal edges of tiles. Miter corners. Provide edge moldings at junctions with other interruptions

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches on center 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.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members. Install runners and cross members in maximum lengths possible to minimize joints.

F. Arrange directionally patterned tiles as indicated on reflected ceiling plans.

G. Install suspended tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material. Install tiles with pattern and grain running in same direction.

1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate, tight fit at borders and around penetrations through tile.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches on center.
3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

H. Coordinate all work installed in ceilings and provide additional hanger wires, framing members, and supports in grids as required for lighting and mechanical fixtures, equipment, and all other loadings imposed on grids, with a safety factor of 4.0 minimum. Provide main grid tees along edges of mechanical and lighting fixtures bearing on the grids.

I. Provide splayed seismic bracing wires as indicated and required by code.

3.4 Field Quality Control

A. Owner will engage a qualified special inspector to perform the following special inspections and prepare reports:

1. Suspended ceiling system.
2. Hangers, anchors and fasteners.
3.5 Cleaning

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

END OF SECTION 09 53 23
SECTION 09 65 00 - Resilient Flooring

PART 1 - General

1.1 Related Documents

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

B. Related Sections:

1. Section 07 92 00 “Sealants.”
2. Section 09 30 00 “Tile.”
3. Section 09 68 00 “Carpet.”

1.2 Submittals

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

B. Shop Drawings: Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts. Show details of special patterns. Indicate seaming layout and locations including boots, drop outs, patch panels, and seams in top metal cap.

C. Samples: 12 inch x 12 inch samples of sheet roll products. Full-size units of each color and pattern of floor tile required. For heat-welding bead, manufacturer's standard width and diameter, but not less than 12 inches long, of each color required.

D. Provide samples showing seamless-installations required. Provide color, and pattern required; with seam running lengthwise and in center of two 6-by-9-inch samples applied to a rigid backing and prepared by installer for this project.

E. Qualification Data: For qualified installer.

F. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.3 Regulatory Requirements

A. Resilient flooring shall be stable, firm, and slip resistant. Comply with CBC Section 11B-302.1. Acceptable demonstration of slip resistance; minimum coefficient of friction 0.6 per ASTM D 2047.

1.4 Quality Assurance

A. Provide a qualified installer who employs workers for this project who are competent in techniques required by manufacturer for resilient products indicated. Engage an installer who employs workers for this project who are trained or certified by manufacturer for installation techniques required. Provide installer with 5 years documented experience with installing products specified.

B. Fire-Test-Response Characteristics: Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm. NFPA E 648.

C. Before beginning actual work, install mockups of at least 8’ x 8’ to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockups for each type of resilient flooring and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
   a. Inside and outside corners.
   b. Integral coves.
   c. Door openings.
   d. Base materials.
   e. Transitions to other finish materials.
   f. Joints.
   g. Corner joints.
   h. Cabinet bases.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

D. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

E. Coordinate with flooring requirements for elevators.

1.5 Delivery, Storage, and Handling

A. Deliver materials in unbroken original protective wrapping with manufacturer’s identification, brand name and label.

1. Store inside, in well ventilated area, protected from weather, moisture, soiling, extreme temperatures and humidity.
2. Lay flat with blocking off ground.
3. Do not stack rolls on top of each other.
4. Do not store rolls against each other, allow ventilation all around roll.
5. Do not allow to be folded.

B. 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 65° F or more than 85° F.

C. Allow material to acclimate to ambient temperatures listed below for 48 hours minimum prior to installation.
1.6 Project Conditions

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65° F or more than 85° F, in spaces to receive floor tile during the following time periods:
   1. 48 hours minimum before installation.
   2. During installation.
   3. 48 hours minimum after installation.

B. Maintain ambient relative humidity between 40% and 60% during installation.

C. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55° F or more than 85° F.

D. Close spaces to traffic during floor tile installation.

E. Close spaces to traffic for 48 hours after floor tile installation.

F. Install floor tile after other finishing operations, including painting, have been completed.

G. Provide necessary testing to assure moisture content and pH levels of substrate are within acceptable range per flooring manufacturer’s recommendations and warranty requirements. Where resilient flooring is applied directly to concrete substrates cured with liquid applied curing compounds test for compatibility with curing compounds. Submit test results in writing.

H. Verify compatibility between joint sealants in substrate and adhesive used to adhere resilient products. Provide adhesive that is compatible with substrate.

I. Maintain adequate ventilation for the removal of moisture and fumes.

1.7 Extra Materials

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish 5 percent of each type, color, and pattern of material installed. Provide material in unopened original manufacturer’s packaging with manufacturer’s labels. Provide new material. Do not provide scrap material.

PART 2 - Products

2.1 Vinyl Composition Tile

A. Subject to requirements, provide products as indicated on the Drawings.

B. Tile Standard: ASTM F 1066, Class 2, through-pattern tile.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch.

E. Size: 12 inches by 12 inches.

F. Colors and Patterns: As selected by Architect from full range of industry colors.
2.2 Resilient Base

A. Resilient Base:

1. Johnsonite; as indicated on the Drawings.
2. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
3. Endura Rubber Flooring; Division of Burke Industries, Inc.
4. Flexco, Inc.
5. Roppe Corporation, USA.


1. Material Requirement: Type TS (rubber vulcanized thermoset).

C. Minimum Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer’s standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Finish: As selected by Architect from manufacturer’s full range.

I. Colors and Patterns: As selected by Architect from full range of colors.

2.3 Resilient Transitions

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
2. Flexco, Inc.
3. Roppe Corporation, USA.


C. Material: Rubber.

D. Profile and Dimensions: As indicated.

E. Colors and Patterns: As selected by Architect from full range of colors.

2.4 Installation Materials

A. Leveling Compound: Latex modified blended hydraulic cement type, Merkote Products “Mer-Ko Underlay L” or Crossfield Products “Dex-O-Tex G-26 Underlayment.” Verify that the compound is compatible with the proposed adhesive.
B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Vinyl Flooring Adhesives: Not more than 50 g/L.
   b. Rubber Flooring Adhesives: Not more than 60 g/L.
   c. Cove Base Adhesives: Not more than 50 g/L.
   d. Rubber Floor Adhesives: Not more than 60 g/L.

C. Provide protective liquid floor polish or wax products as recommended by manufacturer for each particular type of resilient flooring and particular characteristics. Verify product requirements with manufacturer prior to any waxing/polishing.

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.

B. 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.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation indicates contractor’s acceptance of substrate conditions.

D. Proceed with installation only after moisture and pH levels satisfy flooring and adhesive manufacturer’s warranty requirements.

3.2 Preparation

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Mechanically remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Mechanically remove all existing or new paint, coatings, and layout markings.
4. Mechanically remove all materials that are incompatible with adhesives or will bleed through or broadcast through new flooring.
5. Perform alkalinity and adhesion testing. Proceed with installation only after substrates pass testing. Provide written evidence that alkalinity and pH levels are within manufacturer’s written recommendations and meet warranty requirements.
6. Perform pH and moisture testing. Proceed with installation only after substrates pass testing. Provide written evidence that pH and moisture levels are within manufacturer’s written recommendations and meet warranty requirements.
7. Allow concrete substrates to cure 28 days minimum.
8. Check subfloors for level, and make floor slabs true to level and plane within a tolerance of 1/8-inch in 12 feet. Test floor areas both ways with a 12 foot straight edge and repair high and low areas exceeding allowable tolerance. Remove high areas by power sanding, stone rubbing or grinding, chipping off and filling with leveling compound, or equivalent method. Fill low areas with leveling compound. Repair and level the surfaces having abrupt changes in plane, such as trowel marks or ridges, whether or not within the allowable tolerance. Again clean areas where repairs are performed.

9. After leveling, if required, clean substrates of all deleterious substances and foreign matter. Fill cracks or depressions with latex leveling compound of type recommended by flooring manufacturer for the specific job conditions.

10. Prime concrete floor slabs on grade; prime other slabs if so recommended by flooring manufacturer.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate. Fill all depressions and recesses, holes, and cracks resulting from demolition and removal of existing elements, including metal stud tracks and existing flooring and other construction activities.

D. Do not install flooring until it is the same temperature as space where they are to be installed. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation. Maintain temperatures.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

F. Verify that wall surfaces to receive base are free from irregularities, adhesives, joint compounds and other materials which would telegraph through the material. Remove such materials and sand wall surfaces smooth prior to installing base.

3.3 Floor Tile Installation

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from 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. Lay tiles square with room axis in pattern indicated. Do not install floor tiles over expansion joints.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).

D. 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 in closed position. Extend resilient flooring into cabinets and casework without bottoms.

F. Mix sufficient quantity of tiles to complete each area before laying to avoid color variations. Install flooring with tight joints, pattern direction as approved. Lay flooring square with axis of rooms, starting on center lines with the tile joint or tile center so that border tiles are not less than 4-inches-wide, accurately aligned. Install reducer strips at exposed edges of flooring and where shown. Cut flooring mechanically to produce square true edges. Closely trim to pipes, jambs, outlets, and like conditions.
Adhesive application rate shall be as required to avoid telegraphing trowel likes to the surface after maintenance coatings are applied. Adjust tile “runoff” during installation if necessary.

G. 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, nonstaining marking device.

H. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor 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.

I. Adhere floor tiles to flooring 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.

J. Seamless Installation:
   1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
   2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

3.4 Sheet Flooring Installation

A. Comply with manufacturer’s written instructions for installing floor coverings.

B. Unroll floor coverings and allow them to stabilize before cutting and fitting.

C. Lay out floor coverings as follows.
   1. Maintain uniformity of floor covering direction.
   2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
   3. Match edges of floor coverings for color shading at seams.
   4. Avoid cross seams.
   5. Do not install flooring over expansion joints.

D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.

E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
H. Adhere floor coverings 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. Roll flooring in both directions using a 100 pound three section roller.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

2. Chemically-Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly-fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

J. Cove floor coverings up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt top into cap strip. Locate all joints in cap strip over wall stud. Cap strip shall be set in adhesive and fastened through to stud or solid backing with screws.

3.5 Resilient Base Installation

A. Comply with manufacturer’s written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned. Assure that filler pieces are a minimum of 18 inches.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates. Assure that top and bottom of base continuously contact wall and floor, respectively.

E. Do not stretch resilient base during installation.

F. Base and outside corners shall be rolled with a seam roller before adhesive sets.

G. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer’s recommended masonry filler material.

H. Corners:

1. Job Formed Corners:
   a. Outside Corners: use straight pieces of minimum 48 inch lengths. Form without producing discoloration (whitening) at bends.
   b. Inside Corners: Use straight pieces of minimum 48 inch lengths.

2. Install preformed corners, factory formed internal and external corners, and end stops where cove base ends at jambs and offsets.

3.6 Resilient Accessory Installation

A. Comply with manufacturer’s written instructions for installing resilient accessories.
B. Butt resilient transitions to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient flooring that would otherwise be exposed.

C. Install resilient accessories in as long a length as possible to minimize joints. Keep joints at least 48 inches minimum from end conditions.

D. Provide reducer strips to cover all exposed edges of resilient flooring. Use carpet-to-resilient flooring strips at junctions with carpet.

3.7 Cleaning and Protection

A. Comply with manufacturer's written instructions for cleaning and protection of floor tile. Verify requirements with manufacturer prior to performing any work.

B. Perform the following operations immediately after completing flooring installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Do not allow traffic of any kind for a period of 72 hours.

E. Wait 72 hours after installation before performing initial cleaning.

F. Apply wax/polish per manufacturer’s written recommendations to the following resilient flooring:

1. VCT.

G. Do not apply wax/polish to the following resilient flooring:

1. Resilient bases.
2. Homogenous welded seam floor.
4. Rubber flooring.

H. Cover flooring until Substantial Completion.

END OF SECTION 09 65 00
SECTION 09 68 00 - Carpet

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 09 30 00 “Tile.”
   2. Section 09 65 00 “Resilient Flooring.”

1.2 Regulatory Requirements

A. Carpet shall be securely attached and shall have a firm cushion, pad, or backing of no cushion or pad. It shall have a level loop, textured, loop, level cut pile, or level cut/uncut pile texture. Pile height shall be 1/2-inch maximum. Comply with CBC Section 11B-302.2.

B. Exposed edged shall be fastened to floor surfaces and shall have trims on the entire length. Carpet edges shall comply with CBC Section 11B-303.

1.3 Submittals

A. Product Data: For the following, including manufacturer’s written data on physical characteristics, durability, fade resistance and flame resistance and installation recommendations for each type of substrate:
   1. For each type of carpet indicated.
   2. For each type of carpet pad indicated.
   3. For each type of accessory and installation material.

B. Shop Drawings: Show the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
   2. Seam locations, types, and methods.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern type, repeat size, location, pattern and texture direction, and starting point.
   6. Pile direction.
   7. Type, color, and location of insets and borders.
   8. Type, color, and location of edge, transition, and other accessory strips.
   9. Transition details to other flooring materials.
   10. Type of carpet cushion.
   11. Revise layout diagrams as required.
   12. Details in special conditions.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules. Prepare samples from same material and dye lot to be used at site.
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch-long samples.

D. Do not install carpet until written acceptance of layout diagram and all submittals has been received and mock up is approved. Written acceptance does not relieve contractor of responsibility for satisfactory installation of carpet.

1.4 Quality Assurance

A. Provide an experienced, competent installer, employed by contractor who is certified by the Floor Covering Installation Board who can demonstrate compliance with its certification program requirements. Provide installer with 5 years documented experience, and fully experienced in first class commercial installation and with installing type of carpet and pad specified, under similar conditions.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification required, as determined by testing identical products per ASTM E 648.

C. Before beginning actual work, build mockups of at least 8’ x 8’ in surface area to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of carpet type, pattern, finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
   a. Inside and outside corners.
   b. Door openings, framing and thresholds.
   c. Cabinets.
   d. Transitions to other finish materials.
   e. Carpet joints and accessories.
   f. Wall base.
   g. Recessed floor items and cover plates.
   h. Building joints.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.
3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.
4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.
5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.
6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.
D. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

E. Obtain carpeting materials from only manufacturers who will, when requested, send qualified technical representative to project site, to advise installer of proper installation procedures.

F. Comply with Carpet and Rug Institute “Standard for Installation of Textile Floor Covering Materials, CRI-104.” Contractor performing the installation shall be certified by the Floor Covering Installation Board. At least one of the installation crew shall have Master Installer certification of the International Certified Floor Covering Installers Association.

G. Carpeting shall meet requirements of Federal, State and Local Regulatory Agencies for flammability, static control, or other properties as required and as specified herein.

H. Use carpet from one dye lot for each type, pattern and color of carpet.

1.5 Delivery, Storage, and Handling

A. Comply with CRI 104, Section 5, "Storage and Handling."

B. Do not deliver carpet or accessories until notification is received that building and spaces are complete and dry; ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use; overhead work is complete and building and spaces are ready for installation of carpet.

C. Deliver materials in unbroken original mill protective wrapping with manufacturer’s identification, brand name, lot number, mill register numbers and tags attached.

1. Store inside, in well ventilated area, protected from weather, moisture, soiling, extreme temperatures and humidity.
2. Lay flat with continuous blocking off ground.
3. Do not stack carpet rolls on top of each other.
4. Do not store carpet rolls against each other, allow ventilation all around carpet roll. Store carpet roll off floor or ground on blocks.
5. Do not allow carpet to be folded more than 4 hours.
6. Deliver tags to job inspector along with a sample of carpet cut from each bale.

1.6 Project Conditions

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Do not install carpet and carpet pad until space is enclosed and weather proof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use and when overhead work is complete.

C. Do not install carpet and carpet pad over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive. Test concrete for moisture and pH levels and provide written statement from carpet adhesive manufacturer that pH levels and the moisture level are within adhesive manufacturer’s warranty requirements.

D. Where demountable partitions, equipment or other items are indicated for installation on top of carpet, install carpet before installing these items.
E. Verify areas to be carpeted are ventilated to remove fumes from installation materials, and areas are within temperature range recommended by the various material manufacturers for site installation conditions.

1.7 Warranty

A. Provide special project warranty, signed by contractor, installer and manufacturer, agreeing to repair or replace defective materials and workmanship of carpet work during specified warranty periods following substantial completion; attach copies of product warranties. Include relaying, restretching or replacement as necessary at no additional cost.

1. Edge Ravel: 15 years.
3. Wear Guarantee: 15 years.
4. Excessive Surface Wear: For lifetime of carpet, no more than 10 percent of face yarn loss by weight in normal use.
5. Edge Ravel: For lifetime of carpet, no edge ravel in normal use.
7. Tuft Bind: For lifetime of carpet, guaranteed not to zipper, wet or dry, in normal use.
8. Tuft Bind Warranty: Lifetime of carpet.
9. Excessive Static Electricity: For lifetime of carpet, no more than 3.0 kilovolts of static electricity when tested according to AATCC 134 at a relative humidity of 20 percent and a room temperature of 70° F.

1.8 Extra Materials

A. Furnish extra materials, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 10 square yards.
2. Provide required overrun exclusive of carpet needed for proper installation, waste and usable scraps.
3. Deliver and store at Owner’s direction.
4. Carpet Tile: Furnish quantity of full size units equal to 5 percent of amount installed, but not less than 10 square yards.

B. Carpet scraps will be examined by Owner and those to be retained for maintenance purposes will be selected. Burlap wrap selected scraps and deliver to location directed by Owner.

PART 2 - Products

2.1 General Product Requirements

A. Provide only carpet which has passed the following tests:


B. Carpet submitted for approval as equal to specified carpet must be equal in every respect, including color selection.

1. Submittals to include full range of carpet colors and manufacturer’s written specification.
2. Carpet Color/Pattern Texture: Match Architect’s samples or match specified manufacturer’s stock carpet color, pattern and texture.

2.2 Carpet Tiles

A. Subject to requirements, provide one of the following or as indicated on the Drawings:

1. Color and Pattern: As selected by Architect from manufacturer’s full range.

B. Carpet Designation: CPT-1.

C. Face Construction:

2. Construction: Stratatec Patterned Loop; complying with CBC Section 1124B.3.
3. Dye Method: 75% Solution dyed/25% yarn dyed.
4. Color: As scheduled.
5. Gage: 5/64.
7. Pile Height: 0.187 inch, average.
8. Soil/Stain Protection: Ensure

D. Backing System:

1. Primary Tufting Substrate: Synthetic non-woven.
2. Installation Adhesive System: Microencapsulated Tackifier applied to 100% of backing during manufacturing.

E. Tile Size: 36 x 36 inches.

F. Flammability: Pass methenamine pill test, ASTM D 2859.

G. Flame Spread: Critical radiant flux to meet Class I (0.45 watts/sq. cm.) as tested by ASTM E 648.

H. Electrostatic Propensity: 3.0 kV or lower; permanent conductive fiber.

I. 1/2-inch maximum pile height.

2.3 Installation Accessories

A. Leveling Compound: Latex type, Merkote Products “Mer-Ko Underlay L” or Crossfield Products “Dex-O-Tex G-26 Underlayment.” Verify that the compound is compatible with the carpet backing.

B. Water-resistant, mildew-resistant, nonstaining adhesive to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended by carpet and carpet pad manufacturer. Coordinate compatibility of adhesive with joint sealants and substrate. Provide adhesives that comply with limits for VOC content required by authorities having jurisdiction.

C. Provide water-resistant plywood, tackless carpet stripping as required to match pad thickness and that comply with CRI 104, Section 12.2.

D. Hot-melt seam adhesive tape recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
E. Provide heavy-duty rubber carpet edge guard of size and profile indicated and with minimum 2 inches wide anchorage flange or of maximum lengths to minimize running joints; colors selected by Architect from manufacturer’s full range of colors including custom colors.

F. Provide types of adhesives, and other accessory items recommended by carpet manufacturer and installer for conditions of installation and use, without failure during life of carpet.

G. Provide aluminum tackless binder edging by B&T Metals, Roberts Co., or Trimedge.

H. Provide Mercer No. 800 “Imperial Reducer” reducer strips, and No. 15 “Joiner” at resilient flooring, colors as selected by Architect.

I. Vinyl nosings at carpeted stairs shall be Rigid Stair Nosing as manufactured by Johnsonite or approved equal. Colors as selected by Architect.

PART 3 - Execution

3.1 Examination

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.

B. Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet and adhesive manufacturer.
2. Subfloor finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" for slabs receiving carpet.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
4. Moisture and pH levels are in compliance with adhesive manufacturer’s warranty and installation requirements.
5. Do not install carpet if test readings show unacceptable conditions.
6. Verify that concrete slab has cured for 28 days minimum.

C. Verify carpet pattern and color match before cutting to ensure minimal variation between dye lots.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of substrate conditions by contractor, and contractor shall be responsible, at his expense, for correcting unsatisfactory conditions encountered.

3.2 Preparation

A. Clear away debris and scrape up cementitious deposits from concrete surfaces to receive carpet.

B. Patch holes and level to a smooth surface. Seal powdery or porous surface with sealer recommended by carpet adhesive manufacturer.

C. Patch holes and cracks. Sand to level. Seal surface with sealer recommended in writing by carpet adhesive manufacturer.

D. Sequence carpeting with other work so as to minimize possibility of damage and soiling of carpet during remainder of construction period.
E. Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

F. Verify that substrate surfaces are smooth and flat with a maximum variation of 1/8-inch in 12 feet and are ready to receive carpet.

G. Remove coatings, including curing compounds, construction marks, overspray, stains, soap, wax, oil, silicone and other substances that are incompatible with adhesives without using solvents. Use mechanical bead blast methods to create a clean smooth open concrete surface.

H. Commercial vacuum clean substrates to be covered immediately before installing carpet. Damp mop to remove dust that may remain after first vacuuming, allow surface to dry, and again vacuum; repeat procedure if necessary to eliminate all dust. Do not use oiled or chemical treated sawdust or any similar product for dust removal. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

I. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill and level cracks, holes and depressions 1/8-inch wide or wider, and protrusions more than 1/32-inch, unless more stringent requirements are required by manufacturer's written instructions. Fill all depressions and recesses, holes, and cracks resulting from demolition and removal of existing elements, including metal stud tracks and existing flooring and other construction activities. High spots and ridges must be ground down.

J. Store material on site in conditioned space, within building where it will be installed, for a minimum of 48 hours. Install carpet in conditioned space.

3.3 Installation

A. Comply with CRI 104 and carpet and carpet pad manufacturers’ written installation instructions for the following:

1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."

2. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installation."


B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. Install carpet in one piece lengths to greatest extent possible with seams located in non-traffic areas, preferably with seams covered by furnishings and equipment. At doorways, center seams and edges of carpet under the door in closed position.

C. Install carpet in one direction in each room and do not reverse direction at any locations. Align carpet with centerline of room or space, and adjust at edges for wall variations.

D. Install carpet in one-piece lengths between permanent walls unless otherwise approved. Seams are permitted only where shown on the approved layout shop drawings.

E. Follow the highest quality professional installation procedures outlined by the National Association of Floor Covering Installers and the carpet manufacturer’s directions as to workmanship. Cut carpet for seams between tuft rows by methods that prevent damage to tufts or loops, prevent edge ravel, and preserve uniform tuft row alignment and spacing on both sides and across seams. Lay carpet with tuft or loop rows in straight lines both way, free of offsets, waviness, distortion, or misalignment. Cut seam
edges straight and square with backing. Trim carpet at walls, columns, and penetrations for a compressed fit.

F. Extend carpet into doorways without piecing in and seam to the carpet on other side of door under door centerline except where metal thresholds occur; no small filler pieces of carpet will be permitted at doorways. Where material/finish change occurs at doors transition to new material directly under centerline of door in closed position.

G. Coat all butted and glued seam edges with seam sealer applied to bottom of face yarn and entire edge of backings, and produce tight, compressed, invisible seams free of gaps, peaking or ridging.

H. Provide binder bars at all edges of carpet abutting walls or other construction, securely fastened in place. Precisely align splices and tightly miter angles.

I. Double cut carpet to allow intended seam and pattern match. Make cuts straight, true and unfrayed.

J. Do not bridge building expansion joints with carpet.

K. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

L. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

M. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

N. Install pattern as indicated to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

O. Extend carpet under open-bottomed and raised-bottoms obstructions, and under removable flanges of obstructions.

1. Extend carpet into closets and alcoves of rooms indicated to be carpeted, unless another floor finish is indicated for such spaces.
2. Extend carpet under all movable furniture and equipment, unless otherwise indicated.

P. Install carpet edge guard at every location where edge of carpet is exposed to traffic, except where another device, such as an expansion joint cover system or threshold, with an integral carpet binder bar, is indicated; anchor guards to substrate. Comply with accessibility requirements with regards to heights of edges, thresholds and transitions.

Q. Install carpet cushion seams at 90-degree angle with carpet seams.

R. Lay out carpet rolls to minimize number of seams.

S. Run all widths the same direction within the same space.

T. Lay out carpet on floors with run of pile in same direction as anticipated traffic. Maintain uniformity of carpet direction and lay of pile.

U. Install carpet tight to walls and under bottom edges of resilient cove base, where provided.
V. Install carpet with pattern parallel and perpendicular to walls and borders, unless otherwise directed.

3.4 Carpet Tile Installation

A. Comply with manufacturer’s instructions and recommendations for direction of carpet tile; maintain uniformity of carpet tile direction and lay of pile. Comply with applicable accessibility regulations.

B. Determine the center of the room using standard tile laying methods.
   1. Center chalk lines, dividing room into quadrant, should be off-center, if necessary, to ensure that perimeter modules will be half-size or larger.

C. On both sides of chalk line, apply strip of adhesive at least 9 inches in width, using twist-textured paint roller.
   1. When adhesive is ready lay modules firmly along these anchor lines.
   2. Fill in each quadrant section laying using the “stair step” technique, completing the installation from center to corner of room in each quadrant, then moving to the next quadrant.

D. As each module is installed, ensure that installation remains square and conforms to chalk lines.

E. Orient pattern and texture in same direction and as indicated on Shop Drawings.

F. Adhere perimeter tiles and cut tiles with full spread of adhesive.
   1. Dry fit cut tiles and apply adhesive to tile back after tile has been cut.
   2. In corridor areas, use full tiles down center and cut perimeter tile borders.

3.5 Cleaning and Protecting

A. Remove debris from installation, carefully sorting pieces to be saved from scraps to be disposed of.

B. Perform the following operations immediately after installing carpet:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
   2. Vacuum carpet using commercial machine with face-beater element.
   3. Remove protruding face yarn.
   4. Replace carpet and carpet tiles which cannot be cleaned.
   5. Brush all seams and trim protruding pile tufts level.

C. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."

D. Keep construction traffic and personnel off of carpet for 12 hours after installation. Cover and protect installed carpet from damage with heavy non-staining non-permeable cover. Protect carpet during the remainder of construction period. Replace carpet and carpet tiles damaged during construction period.

E. Maintenance Materials: Deliver specified overrun of carpet tile to Owner’s designated storage space, properly packaged (paper wrapped) and identified. Dispose of smaller pieces as “construction waste.”

F. As each carpet area is completed, clean up all dirt and debris, remove spots and soiling with proper cleaner, trim off loose threads with sharp scissors, and vacuum entire area clean.
G. After all installations are complete, carpet manufacturer’s technical representative shall instruct Owner’s personnel in maintenance of carpeting. Give instruction at time and location designated by Owner.

END OF SECTION 09 68 00
SECTION 09 90 00 - Painting

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 07 92 00 “Sealants.”
2. Section 08 11 13 “Steel Doors and Frames.”
3. Section 09 29 00 “Gypsum Board.”
4. Section 09 53 23 “Suspended Ceilings.”

1.2 Submittals

A. Product Data: For each type of product indicated. Submit a complete list identifying each material by manufacturer’s name, product name and number, including primers, thinners, and coloring agents, together with manufacturers’ catalog data fully describing each material as to contents, recommended usage, and preparation and application methods. Identify surfaces to receive various paint materials. Do not deviate from approved list.

B. Samples: For each type of paint system and in each color and gloss of topcoat indicated.

1. Submit 7 (seven) samples on rigid backing, 8 inches square.
2. Step coats on samples to show each coat required for system including primer.
3. Label each coat of each sample with manufacturer and product designation name and number.
4. Indicating tinting of each coat.
5. Indicate color of finish coat.
6. Indicate percentage of gloss for finish coat.
7. Prepare sample on piece of actual substrate material that paint will ultimately be applied to.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

D. Submit manufacturer’s current written instructions and recommended methods of installation including substrate preparation and application rates.

1.3 Quality Assurance

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
B. Before beginning actual work, install mockups of at least 8’ x 8’ in surface area to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type, color and sheen of paint. Construct mockup in a layered fashion to show all elements of the assembly, including primers and base coats. Include the following:
   a. Inside and outside corners.
   b. Window openings.
   c. Door openings.
   d. Transitions to other finish materials.
   e. Joints, casings, reveals and other accessories.
   f. Sealant joints.
   g. Actual substrate materials and conditions.
   h. Simulate actual lighting conditions for viewing mockups.
   i. Selected colors.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

7. Coordinate with work of other sections in support of mockup construction. Paint mockups may be part of mockups required by other sections as long as requirements of Section 09 90 00 “Painting” are satisfied.

C. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

D. Provide painter with 10 (ten) years’ experience in the type of painting applications specified for this project.

E. Comply with “Best Practices” of the American Plywood Association (APA) for painting plywood and all other manufactured wood sheet materials.

F. Conform to California Air Resource Board (CARB) and other applicable local air quality regulations for products and application.

G. Coordinate with other trades and work of other Sections that will be applying primers to work of those Sections, to ensure compatibility of the total paint system over substrate. Provide information on top coats to ensure use of compatible primers. Omit primer on metal surfaces that have been shop primed.
H. This Section includes painting of all work, items and surfaces which are normally painted in a building of this type and level of quality, and shall be included in the Contract, whether or not painting of a specific item or surface is specifically called out and included in the drawings or mentioned in specifications. Unless specifically noted, include painting of all exposed surfaces whether or not colors are indicated. Where products or surfaces are not specifically indicated for a specified finish, paint these the same as adjacent similar products and surfaces.

I. Schedule indications on drawings are general and do not necessarily define the detail requirements. Include all detailed refinements for the required complete finishing of all spaces and rooms.

J. Include painting of all items and assemblies even if color is not yet indicated.

K. Work Not to be Painted: Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

1. Do not paint factory- and shop-finished components, including but not limited to the following:
   b. Plastic laminate-faced wood doors.
   c. Toilet partitions.
   d. Acoustic Materials: Suspended acoustical t-bar grid and acoustical panels.
   e. Finished mechanical and electrical equipment.
   f. Light fixtures, unless specifically noted.
   g. Switchgear.
   h. Distribution cabinets.

2. Do not paint concealed surfaces, including but not limited to the following:
   a. Furred areas.
   b. Utility chases and pipe spaces.
   c. Duct, piping and conduit shafts.

3. Do not paint natural metal, plated metal and factory-finished metal surfaces (except where specifically indicated) including but not limited to the following:
   a. Anodized aluminum.
   b. Stainless steel.
   c. Chromium plate.

4. Do not paint operating parts, including but not limited to the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.

5. Do not paint over Underwriters Laboratories, Inc. (UL) Factory Mutual Research Organization (FM) and other code-required labels and over equipment names, identifications, performance ratings, and nomenclature plates.

1.4 Delivery, Storage, and Handling
A. Deliver paint materials to project site in manufacturer’s original unopened containers bearing manufacturer’s label, with manufacturer’s name, logo, paint type, sheen, stock number, date of manufacture, contents by volume for pigment solids and vehicle constituents, thinning and mixing instructions, color name and number, and shelf life. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45° F until ready for use.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Place oily rags and waste in a metal container and remove from project site daily.
3. Comply with health and fire regulations.

1.5 Project Conditions

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 55° and 95° F. Avoid painting surfaces when exposed to direct sunlight.

B. Do not apply paints when relative humidity exceeds 50 percent; or at temperatures less than 55° F above the dew point. Do not apply paint in damp or rainy conditions, or to damp or wet surfaces, or when fog or inclement weather is expected within the drying /curing time recommended in writing by manufacturer.

C. Moisture test surfaces prior to applying any paint coatings. Prior to paint application verify that substrates have a maximum moisture content that complies with paint manufacturer’s written recommendations. Provide statement on paint manufacturer’s letterhead that moisture levels in substrates satisfy warranty requirements.

D. Perform pH tests on concrete and masonry substrates. Prior to paint application verify pH levels are within paint manufacturer’s written recommendations. Provide statement on paint manufacturer’s letterhead that pH levels in substrates satisfy warranty requirements. If required by paint manufacturer’s written recommendations due to alkali content, apply an appropriate surface primer to concrete and masonry prior to applying acrylic block filler.

E. Provide substrates that are dry and well-cured.

F. Minimize wind and drafts resulting in minimal direct air movement across surface being painted.

G. Do not paint under dusty conditions. Remove dust from substrate before painting. Do not allow dust to adhere to wet surface.

H. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45° F for 24 hours before, during, and 48 hours after application of finishes, unless permitted by manufacturer’s instructions and recommendations.

I. Provide full lighting level approximating final permanent lighting during application.

J. Apply paints to exterior substrates with a minimum 40° F to maximum 80° F.

1.6 Extra Materials

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 (five) percent, but not less than 5 gal. (5 gallons) of each material and color applied.
2. Label each container with color, gloss and original application locations, in addition to the manufacturer’s label.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Benjamin Moore & Co.
2. Dunn-Edwards Corporation.
3. Frazee Paint.
5. Vista Paint.

2.2 Paint Materials

A. Provide materials for use within each paint system that are compatible with one another and compatible with substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

B. For each paint system, provide products recommended in writing by topcoat manufacturer for substrate indicated. Provide all products within a paint system including thinners and coloring agents, produced by a single manufacturer including prep coats and primers.

C. Provide products that comply with jurisdictional requirements for VOC content, exclusive of colorants added to a tint base.

D. Provide paint that contains 30-45% solids, minimum.

E. In areas prone to mildew growth such as coastal areas or high humid environments, add a mildewcide to paint materials in quantities recommended in writing by manufacturer.

F. All paints and primers shall be ready mixed in original containers. Factory mix paint materials to correct colors, sheen and consistency for application.

PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions, with applicator present, for compliance with requirements for maximum moisture content, pH levels and other conditions affecting performance of work.

B. Contractor is aware of a condition known as critical lightning. This condition causes shadows that accentuate even the slightest surface variations. A base sealer will provide tooth for succeeding paint coatings but does not equalize smoothness of surface texture. Any corrective action must be done by drywall finisher / installer prior to painting. Coordinate with drywall installer to achieve desired results.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Unsatisfactory surfaces and materials must be corrected by applicable trade before painting. Surfaces which cannot be prepared or painted as specified shall be immediately reported in written RFI to Architect. Specifically note each specific condition.
E. In reconstruction areas where permanent installed items have been removed; provide textures, primers, and coatings as needed to eliminate ghosting and to make surface visually indistinguishable in all respects to adjacent exposed surfaces.

F. Begin coating application only after unsatisfactory conditions have been corrected and are within manufacturer’s written recommendations and requirements of Contract documents. Architect shall be final judge on satisfactory conditions. Beginning coating application constitutes contractor’s acceptance of substrates and conditions.

G. Notify Architect with written RFI of any problems anticipated using paint materials specified over substrates indicated or project conditions. Failure to provide written RFI prior to starting painting operations constitutes contractor’s acceptance of substrates and conditions.

3.2 Preparation

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual” for preparation of substrates indicated. Surfaces which cannot be prepared or painted as specified shall be immediately brought to the attention of the Architect in writing. Starting of work without such written notification constitutes contractor’s acceptance of substrates and conditions.

B. Remove plates, machined surfaces, and similar items already in place that 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.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
3. Do not apply paint in areas where dust is being generated. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, dust, and incompatible paints and encapsulants, including construction layout marks and stains.

1. Remove incompatible primers and coatings, and reprime substrate with compatible primers as required to produce paint systems indicated.
2. Prepare all surfaces per manufacturer’s written recommendation and per SSPC SP1, SP2 and SP3 as required by substrate and paint system requirements and as required by Contract documents.
3. Screen, cover or mask adjacent surfaces and materials which are not to receive paint or paint dust. Use appropriate light or medium tack masking tape.
4. Clean all interior wall surfaces of loose, peeling, and scaly paint, dirt, dust, rust chalk and other foreign matter as required to provide a clean sound surface for the new coatings and paints.
5. Clean all exterior walls and surfaces of loose, peeling, and scaly paint, dirt, dust, rust, chalk and other foreign matter by power washing as necessary to provide clean sound surface for new coatings and paints.
6. Provide barrier coats over incompatible primers or remove and reprime.
7. Correct minor surface defects. Major defects shall be repaired by replacement.
8. Repair, patch and fill all surfaces as necessary to match surrounding surface texture and to present uniform surface appearance matching surrounding surfaces. Repair all cracks and voids greater than 1/32-inch as recommended in writing by paint manufacturer.
9. Verify that all exterior openings and joints are sealed prior to painting. Deteriorated sealant shall be removed and new backing material and sealant shall be installed prior to painting. Coordinate with sealant trades. Do not paint failed sealant joints. Determine compatibility between paints...
and joint sealers. Notify Owner of incompatibilities and other conditions which are detrimental to proper joint sealing and paint adhesion.

10. Verify that recessed and filled fasteners are smooth and not failing. Coordinate corrections with appropriate trade.

D. Measure moisture and pH at surfaces. Do not apply finishes unless moisture and pH content is below paint manufacturer’s written warranty and application requirements.

E. Concrete Substrates: Remove release agents, grease, oils, dust, salts, alkali powder, dirt, rust stains, 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 and Contract documents. Roughen as necessary to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation. Use abrasive blast cleaning methods if necessary. Fill all voids, cracks and depressions.

F. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceeds that permitted in manufacturer's written instructions, and requirements of contract documents.

G. Concrete Masonry Substrates: Remove 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, and requirements of contract documents.

H. Ferrous Metal Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer and requirements of contract documents. In severe exposure conditions such as coastal areas subject to salt water, humid environments, or environments with exposure to corrosive chemicals, apply two coats of primer to ferrous metals. Surfaces shall be primed within 3 hours after preparation.

I. Shop Primed Steel Surfaces: Comply with SSPC requirements.

1. Sand and scrape to remove loose primer and rust.
2. Feather edges to make touch up patches inconspicuous.
3. Clean surfaces with solvent to remove oil and grease.
4. Treat surfaces with phosphoric acid solution, ensuring cleaning of weld joints, bolts and nuts.
5. Clean surface of dust with tackrags.

J. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal with a solvent or water based degreaser. To produce clean surfaces, etch cleaned galvanized metal surfaces with an etching solution, such as Jasco Prep and Prime or approved equal before applying primer. Clean acid etch solution completely from surfaces. Thoroughly dry and prime surface within 3 hours of acid etching.

K. Shop Coated Metal: Degrease and clean of foreign matter. Clean and spot paint field connections, welds, soldered joints, burned or abraded portions with same material used in shop coats. After complete hardening, sand entire surface for coat to follow.

L. Aluminum and Non-Ferrous Substrates: Remove surface oxidation with acid etching solvent solution, rinse and thoroughly dry surfaces.

M. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer. Verify compatibility of primer with sealer before application.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime and backprime all surfaces of wood including cut and uncut edges, ends, faces, undersides, and backsides of wood including wood paneling, doors, windows, trim and cabinets. Use clear sealer to back prime wood receiving transparent finishes.
4. For woods prone to tannin bleed (i.e., redwood and cedar,) apply 2 coats of primer.
5. After priming, fill holes, cracks and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
6. Fill all molding and trim joints and mortises completely and sand smooth prior to painting.

N. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth. Touch-up minor defects with spackle, sand smooth and flush. Spot prime repairs. All drywall surfaces to be dust free before painting. Verify that all surfaces have received a skim coat as specified in Section 09 29 00 “Gypsum Board.”

O. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry. Fill hairline cracks with Portland cement patching material. Test and ensure plaster is sufficiently dry to receive paint finish.

P. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

Q. Existing surfaces to be recoated shall be thoroughly cleaned and prepared as recommended in writing by paint manufacturer. Patches and bare areas shall be spot primed with same primer as required for new surfaces.

R. Newly poured bare concrete floors to be cleaned with a 5 percent solution of muriatic acid or other acid etching cleaner. Flush floor with clean water to remove acid, neutralize with ammonia and rinse; allow to dry.

S. Existing floors scheduled to be painted shall be bead blasted to expose bare concrete in all areas. Test for moisture level as required by Contract documents. Vacuum before painting.

T. Enameled Woodwork: Remove handling marks and effects of exposure to moisture with a thorough sanding over all surfaces of the exposed portions, using at least 150 grit or finer sandpaper and thoroughly clean all surfaces before applying sealer. After priming, putty nail holes, cracks, or other defects with putty matching color of finish paint. Cover knots and sappy areas with shellac or approved knot sealer. Sand each base coat smooth when dry.

U. Fixtures, Equipment and Hardware Items: Coordinate with the work of other sections; coordinate removal of fixtures, equipment, and hardware as required to perform painting. Items to be removed include, without limitation: signs and graphics, switch and receptacle plates, escutcheons and plates, all surface-mounted equipment, free standing equipment blocking access, grilles and louvers at ducts opening into finished spaces, and other items as required and directed.

V. Surfaces Not Mentioned: Prepare surfaces according to recommendations of the paint manufacturer. Submit preparation steps to Architect for approval.

W. Previously Painted Surfaces: Shall be repaired, prepared and spot primed as required and as recommended by the manufacturer of the paint.

3.3 Application

A. Verify compatibility of primers with surfaces on which to be applied. If primer or finish coating is incompatible, follow manufacturer’s recommendations.
B. Do not apply initial coating until moisture and pH content of surface is within limitations recommended by the paint manufacturer.

C. Mix and prepare paint materials according to manufacturer’s written instructions.

D. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

E. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

F. Use only thinners approved by paint manufacturer and only with recommended limits. Do not thin paints or primers, unless authorized by Architect in writing.

G. Apply primer to surfaces that have been properly cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

H. The minimum number of coats and film thickness are the same regardless of the application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer’s written instructions, sand between applications.

I. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a uniform, minimum dry film thickness equivalent to that of broader surfaces.

J. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

K. Apply primers, intermediate coats and finish coats of paint as scheduled below and in compliance with paint manufacturer’s instructions and recommendations.

L. Apply paint materials no thinner than manufacturer’s recommended spreading rate to achieve dry film thickness indicated.

M. Coating systems specified indicate a minimum number of coats. Do not thin primers or paints; apply paint taken directly from manufacturer’s containers. Apply at coverage rates recommended by paint manufacturer. Apply primer coat as recommended by manufacturer to properly prepare surface for finish coats, one coat minimum. Apply additional primer coats, as necessary, to cover suction spots or unsealed areas, to properly prepare surface for finish coats at no additional cost to Owner. Apply finish coats as recommended by manufacturer, two coats minimum. Apply additional finish coats as needed to completely hide base substrates and achieve the desired consistency, uniformity in finish surface, and sheen at no additional cost to Owner. Apply paint in manner that avoids sags, runs or other evidence of poor workmanship.

N. The numbers given in the Painting Schedule indicate the types of paints required for each surface, identified by their number in white. The actual paint to be applied on each surface shall be the same material in the color or colors as selected, and as approved on submitted samples. Allow for the use of several colors in each room or space, and for doors, frames, dadoes, trim and other items to be finished in different colors.

O. Degrees of gloss shown on drawings and herein specified are approximate only. The exact degree of gloss required for each surface will be determined and approved by Architect during paint sample
submittal. Materials shall meet the following requirements for degree of gloss when tested according to ASTM D 523, using Gardner Laboratory 60 degree gloss meter after 14 days. Percentage of gloss:

1. Flat or eggshell: 25%-55%.
2. Satin or semi-gloss, 55%-70%.

P. Apply paints according to manufacturer's written instructions.

1. Flat and eggshell finishes may be rolled or brushed on drywall, plaster and CMU. Spray-apply primer, intermediate and finish coats on all other surfaces.
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. Paint inside surfaces of all non-electrical panels and covers and inside of all non-electrical boxes.

Q. Do not paint over dirt, rust, scale, grease, mildew, mold, moisture scuffed surfaces, or conditions detrimental to durable uniform paint film.

R. Apply acid etching primers within 3 hours of washing and drying substrates.

S. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. If undercoats or other conditions show through topcoat, apply additional coats until cured film as a uniform paint finish, color, and appearance. Comply with manufacturer’s written recommendations for drying times between succeeding coats.

T. Lightly sand and remove all dust between succeeding coats.

U. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

V. Painting Mechanical and Electrical Work: Paint all exposed items, both new and existing, in interior and exterior conditions including, but not limited to, the following:

1. Uninsulated metal piping and conduit.
2. Uninsulated plastic piping.
3. Pipe hangers and supports.
4. Tanks that do not have factory-applied final finishes.
5. Visible portions of internal surfaces of metal ducts to a point 3 feet back from duct outlet, without liner, behind air inlets and outlets.
7. Paint all exposed surfaces in plenum spaces that can be visually seen through return and supply registers including: equipment, ductwork, piping and conduit.
8. Paint all recessed fire sprinkler head cover plates, semi-recessed and exposed sprinkler head trims to match adjacent surfaces.
10. Exposed ductwork jacketing.

W. Do not paint over prepainted mechanical equipment, electrical switch covers, transformers, UL labels, equipment and piping labels. Do not paint over fusible links or sprinkler heads. Do not paint valve assemblies.
X. Apply block filler to masonry units with squeegee in two directions, up-down and left-right, at a rate to ensure complete coverage with pores and pits filled free of pinholes and depressions.

Y. Leave all parts of molding and ornaments clean and true to details with no undue amount of paint in corners and depressions.

Z. Make edges of paint adjoining other material or color clean and sharp with no overlapping.

AA. Refinish whole wall where portion of finish is deemed unacceptable by Architect.

BB. All materials shall be spray-applied evenly with proper film thickness and free of runs, sags, skips and other defects, except drywall, plaster and CMU with flat or eggshell finish. Varnishes shall be sanded lightly between coats, dusted and cleaned before recoating.

CC. Hardware, hardware accessories, plates, lighting fixtures and similar items in place shall be removed prior to painting and replaced upon completion of each space.

DD. Heating and other equipment adjacent to walls shall be disconnected, using workmen skilled in appropriate trades, and moved to permit wall surfaces to be painted. Following completion of painting, expertly replace and reconnect.

EE. Wash bare metal grilles and ducts indicated to be painted with solvent, wash with etching solution then prime and paint as scheduled.

FF. Paint doors on tops, bottoms and edges same as door faces after fitting.

GG. Paint backside and inside faces of access panels, cover doors, frames, and removable or hinge covers to match exposed fronts.

HH. Carry finish coats to natural breaks and transitions.

II. Provide even, smooth color and finish with no apparent marks.

JJ. Provide wet paint signs, barricades, warning tape and other devises to protect newly finished surfaces. Remove after work is completed and paint has thoroughly dried.

3.4 Field Quality Control

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:

1. Owner will engage the services of a qualified testing agency to sample paint 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.

3. Owner may direct contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from project site, pay for testing, and repaint rejected surfaces. Contractor at Owner’s discretion shall remove rejected materials from previously painted surfaces prior to re-preparing surfaces and re-applying approved paint coating systems.
3.5 Cleaning and Protection

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces. Clean and repair blemishes to all surfaces caused by work of this Section.

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. Leave surfaces in a first class condition.

E. Runs, sags, misses, holidays, stains and other defects in painted surfaces, including inadequate coverage, mil thickness, inconsistent sheen or uniformity of appearance shall be satisfactorily repainted as necessary. If a portion of a larger area is deemed unsatisfactory, the entire area of surface shall be stripped, re-prepared and re-painted with approved paint systems, at Owner’s discretion.

3.6 Painting Schedule

A. The following paint schedule is based upon Frazee Paint Systems as a basis of design; other paint systems may be proposed on an “approved equal” basis. Architect is sole judge of acceptability of paint system. Verify all paint systems and components with substrate materials, timing of application requirements, and appropriateness and compatibility with substrate materials prior to ordering paint materials. Provide appropriate paint materials for proposed substrates at no additional cost or time to Contract.

B. Interior Paint Gloss:

<table>
<thead>
<tr>
<th>Interior</th>
<th>Paint Generic</th>
<th>Gloss Level</th>
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<tbody>
<tr>
<td>Classrooms</td>
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<td>Halls</td>
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<td>Restrooms</td>
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<td>Offices</td>
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<td>Food Preparation</td>
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<td>Cafeteria</td>
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<td>Gymnasium</td>
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<td>Janitor Closet</td>
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<td>Ceiling</td>
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C. Interior Paint Systems:

1. Gypsum Board Drywall:

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2. Concrete, Plaster and Fiber Cement Siding:

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3. Non-Ferrous Metal – Galvanized / Aluminum:

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4. Ferrous Metal – Iron / Steel:

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END OF SECTION 09 90 00
SECTION 10 11 00 - Visual Display Units

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 05 40 00 “Cold-Formed Metal Framing.”
   2. Section 09 22 16 “Non-Structural Metal Framing.”
   3. Section 09 29 00 “Gypsum Board.”
   4. Division 26 Sections for wiring and other electrical work associated with power-operated visual display surfaces.

1.2 Submittals

A. Product Data: For each type of product indicated.
   1. Include motor capacities and individual panel weights for sliding visual display units.
   2. Include computer system requirements for electronic markerboards.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Show location of panel joints.
   2. Show location of special-purpose graphics for visual display surfaces.
   3. Include sections of typical trim members.
   4. Include wiring diagrams for motor-operated, sliding visual display units.

C. Samples: For each type of visual display surface indicated and as follows:
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final work. Include one panel for each type, color, and texture required.
   2. Trim: 6-inch-long.
   4. Accessories: Full-size sample of each type of accessory.
   6. Anchoring and mounting devices.

1.3 Quality Assurance

A. Provide an authorized representative of visual display unit manufacturer for installation and maintenance of units required for this project. Installer shall have a minimum of 5 years documented experience in the installation of the types of visual display units specified.

B. Obtain each type of visual display surface and product through one source from a single manufacturer. Provide visual display units from a manufacturer with a minimum of 10 years documented experience in the manufacturing of the types of visual display units specified.

C. Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on a specific system. Do not modify intended aesthetic effects, as judged solely by Architect, except with
Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Provide materials with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E 84. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Flame Spread: 15 maximum.
2. Smoke Developed: 20 maximum.

E. Provide listed and labeled electrical components, devices, and accessories as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Before beginning actual work, install mockups of actual size for prefab units and 8’ x 8’ for tackable surfaces to demonstrate aesthetic effects and set quality standards for materials and execution. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of visual display surface and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
   a. Inside and outside corners.
   b. Window openings.
   c. Door openings.
   d. Top, bottom and side details.
   e. Transitions to other finish materials.
   f. Joints, reveals, casings and other accessories.
   g. Sealant joints.
   h. Sheathing, framing and substrates.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.
3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.
4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.
5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.
6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

G. Conduct pre-fabrication meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make necessary adjustments in fabrication strategy to meet requirements without additional cost or time to Contract.

H. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.
I. Do not begin installation of visual display boards until environmental conditions approximate normal occupied conditions.

1.4 Delivery, Storage, and Handling

A. Deliver factory-built visual display boards completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display units vertically with packing materials between each unit.

C. Deliver visual display surfacing in rolls in unbroken original mill protective wrapping with manufacturer’s identification, brand name, lot number, mill register numbers and tags attached.

1. Store inside, in well ventilated area, protected from weather, moisture, soiling, extreme temperatures and humidity.
2. Lay flat with blocking off ground.
3. Do not stack rolls on top of each other.
4. Do not store rolls against each other, allow ventilation all around roll. Store roll off floor or ground on blocks.
5. Do not allow to be folded.

1.5 Project Conditions

A. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Where field measurements cannot be made due to progress of the work, coordinate with appropriate trades to establish dimensions and proceed with Shop Drawings. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting in the field.

B. Coordinate with work of framing and substrates to assure adequate location and extent of blocking and backing to attach and support visual display surfaces.

1.6 Warranty

A. Provide warranty to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Surfaces lose original writing and erasing qualities.
   b. Surfaces become slick or shiny.
   c. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period: Life of the building.

B. Provide warranty to repair or replace electronic markerboards that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - Products

2.1 Markerboard Assemblies

A. Provide balanced, high-pressure, factory-laminated porcelain-enamel markerboard assembly of 3-ply construction consisting of backing sheet, core material, and 24 gage minimum, porcelain-enamel steel face sheet complying with PEI: 5-104 with low-gloss finish.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. ADP/Lemco, Inc.
   b. Best-Rite Manufacturing.
   c. Claridge Products & Equipment, Inc.
   d. Egan Visual Inc.

2. Hardboard Core: 7/16-inch-thick formaldehyde free MDF; with 24 gage minimum, galvanized steel sheet backing.

3. Provide moisture-resistant thermoplastic laminating adhesive.

4. Provide moisture barrier aluminum foil back.

B. Provide porcelain writing surface of three (3) uniform coats as follows:

1. Nickel deposition coat of 2 grams/sq. ft.
2. Cobalt primer coat of .003-inch minimum thickness.
3. Marker board surface coat of .003-inch minimum thickness. A porcelain surface is fused to the steel at temperatures of over 1400° F by NCO.

C. The following marker board surfaces are not acceptable.

1. Low fired organic (paint) coatings.
2. Porcelain coatings of less than .006-inch minimum thickness on writing side and .003-inch on reverse side.
3. Porcelain coating on one side only.

D. Provide aluminum frame and chalk rail.

2.2 Tack Assemblies

A. Subject to requirements, provide products by one of, or equal to, the following:

2. ADP/Lemco, Inc.
5. Egan Visual Inc.
6. Walltalkers; a division of RJF International Corporation.

B. Provide materials in manufacturer’s full width rolls.

C. Provide vinyl-fabric-faced tack surface factory laminated to 1/2-inch-thick fiberboard backing. Provide wrapped edges.
2.3 Visual Display Rails

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Best-Rite Manufacturing.
2. Egan Visual Inc.
3. Peter Pepper Products, Inc.

B. Provide horizontal, wall-mounted, extruded-aluminum support rails; capable of gripping and suspending paper directly from rail. Finish: Clear anodic.

2.4 Modular Support System for Visual Display Boards

A. Subject to requirements, provide products by one of, or equal to, the following:

1. AARCO Products, Inc.
2. Claridge Products & Equipment, Inc.

B. Provide 72-inch-long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Standards shall be punched at not less than 4 inches o.c. Finish: Clear anodic.

C. Provide extruded aluminum panel clips.

2.5 Visual Display Fabric

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Best-Rite Manufacturing.
3. Walltalkers; a division of RJF International Corporation.

B. Provide visual display fabric intended for use with dry-erase markers and as a projection surface, and consisting of low-gloss, plastic film bonded to fabric backing; not less than 0.020-mil total thickness. Color as selected by Architect from manufacturer’s full range.

C. Provide wall-covering adhesive recommended by manufacturer for adhering visual display fabric to wall surface.

2.6 Accessories

A. Provide factory-applied aluminum accessories fabricated from extruded aluminum; ASTM B 221 Alloy 6063 of size and shape indicated. Satin finish.

B. Provide extruded aluminum ASTM B 221 Alloy 6063 box type chalk tray with slanted front, grooved tray, and cast-aluminum end closures. Satin finish.

C. Provide the following accessories:

1. Display Rail: Continuous and integral with rail; fabricated from cork approximately 1 to 2 inches wide.
2. End Stops: Located at each end of rail.
3. Hooks: Two hooks for every 48 inches of rail or fraction thereof.
4. Hooks and Clips: Two hooks with flexible metal clips for every 48 inches of rail or fraction thereof.
5. Flag Holder: One for each room.
6. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
7. Provide manufacturer’s approved mounting hangers, brackets and fasteners for installation of units.
8. Furnish concealed fasteners and wall mounting devices, complete for each application, as shown on the drawings and the approved submittals.

2.7 Fabrication

A. Shop assemble visual display surfaces and units to greatest extent possible.

B. Provide laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with flexible, waterproof adhesive. Laminate at lowest possible temperature to reduce steel and porcelain stresses and achieve superior enamel and hardness.

C. Coordinate factory-assembled visual display units with trim and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board.
2. Provide vertical-joint spline system between abutting sections of markerboards.
3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as necessary.
4. Where there is a texture or pattern in vinyl tack board face, the pattern or texture shall align precisely with the surround frame, square in the opening.
5. Wrapped edges of tack board shall have corners carefully lapped and cut, in order to prevent open seams.
6. Finish of all exposed materials shall be complete, uniform matching selected samples and free from blemish and rough edges.

D. Fabricate aluminum frames straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.

1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.8 Aluminum 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. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

D. 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.
E. 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.

F. Powder-Coat Finish: Apply manufacturer's standard baked finish, complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.

C. Examine walls and partitions for proper backing and attachment for visual display surfaces.

D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with work constitutes contractor’s acceptance of substrate conditions.

3.2 Preparation

A. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display fabric and surfaces. Seal wall surfaces indicated to receive visual display surfaces.

C. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 Installation

A. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Do not install boards on wet or damp walls or in damp and humid weather conditions.

3.4 Installation of Factory-Fabricated Visual Display Units

A. Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

1. Attach chalk trays to boards with fasteners at not more than 12 inches o.c.
B. Install display rails in locations and at mounting heights indicated on Drawings. Attach to wall surface with fasteners at not more than 16 inches o.c.

C. Install sliding visual display units in recessed locations and at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches o.c.
   1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

D. Install electronic markerboards in locations and at mounting heights indicated on Drawings, or if not indicated, at 72 inches above finished floor to top of markerboard. Attach to wall surface with manufacturer's recommended mounting hardware.

3.5 Installation of Visual Display Wall Panels

A. Attach marker wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels. Comply with manufacturer’s instructions and recommendations for adhesive installation over substrate surfaces. Install Tackable panels as indicated on the Drawings.

B. Attach marker wall panels to wall surface with thin layer of adhesive at 16 inches o.c. horizontally and vertically.
   1. Join adjacent wall panels with concealed steel splines for smooth alignment.
   2. Join adjacent wall panels with exposed, H-shaped aluminum trim painted to match wall panel.

C. Attach tack wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels.

3.6 Cleaning and Protection

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 00
SECTION 10 14 00 - Signs

PART 1 - General

1.1 Related Documents

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

B. Related Sections include:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 07 92 00 “Sealants.”
3. Section 08 11 13 “Steel Doors and Frames.”
4. Section 08 80 00 “Glazing.”
5. Section 09 22 16 “Non-Structural Metal Framing.”
6. Section 09 29 00 “Gypsum Board.”
7. Section 09 30 00 “Tile.”
8. Section 09 90 00 “Painting.”
9. Section 10 11 00 “Visual Display Units.”
10. Section 10 44 00 “Fire-Protection Specialties.”
11. Division 26 Electrical Sections.

1.2 Submittals

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

B. Shop Drawings: Show fabrication and installation details for signs.

1. Show style, configuration and profiles of each sign.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
5. Mounting details.
6. Submit a matrix indicating the following:

   a. Room name.
   b. Sign number.
   c. Exact wording, symbols and Braille to be used on each sign.
   d. Use same room and sign numbers used in Drawings.
   e. Whether a sign requires a matched backer board (glass applications).

C. Samples: Provide 1 full size for each sign type and for each color and texture required. Samples must be identical in color, size, shape and material to signs that will be installed.

1.3 Quality Assurance

A. Regulatory Requirements: Comply with applicable provisions in ADA Accessibility Guidelines and California Title 24. Provide Braille signs as required by Accessible regulations.
B. Provide electrical components, devices, and accessories that meet listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Drawings indicate design intent only for signs. Signs are a design build item by contractor. Include design drawings and fabrication of all sign elements including footings, structural connection, internal support, electrical wiring and all related elements for a complete installation.

D. Provide all signs as a product from one manufacturer who has 10 years documented experience in the fabrication and distribution of signs similar in type to those specified.

E. Before beginning actual work, install mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

   1. Build mockups for each type of sign installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
       a. Full size signs.
       b. Mounting.
       c. Surrounding finishes.
       d. Text and symbols.
       e. Sealants.
       f. Underlayments.

   2. Reviewed mockups may become part of the completed work if protected in place and left undisturbed at time of Substantial Completion.

   3. Do not proceed with work until mockup is reviewed by Architect. Reconstruct mockup as necessary to obtain Architect’s review and notice to proceed.

   4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

   5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

   6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

F. Conduct pre-fabrication meeting at project site to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make necessary adjustments in fabrication strategy to meet requirements without additional cost or time to Contract.

G. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

H. Installer shall be either the fabricator or a firm approved by the fabricator which specializes in installation of signs, having a minimum of 5 years full time experience installing signs of similar scope and complexity.
PART 2 - Products

2.1 Materials

A. Aluminum Castings: ASTM B 26, of alloy and temper appropriate for casting process used and for use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B 209, alloy and temper appropriate for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.

C. Aluminum Extrusions: ASTM B 221, alloy and temper appropriate for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.


G. Bronze Plate: ASTM B 36.

H. Copper Sheet: ASTM B 152.

I. Steel:
   1. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008.
   2. Stainless-Steel Sheet: ASTM A 240.
   3. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529.
   4. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

J. Fiberglass Sheet: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels with a minimum tensile strength of 15,000 psi when tested according to ASTM D 638 and with a minimum flexural strength of 30,000 psi when tested according to ASTM D 790.

K. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA.

L. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
   1. Impact Resistance: 16 ft-lbf/in. per ASTM D 256, Method A.
   2. Tensile Strength: 9000 lbf/sq. in. per ASTM D 638.
   3. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.

M. Die-cut applied vinyl characters from vinyl film of nominal thickness of 3 mils with pressure-sensitive adhesive backing, suitable for exterior applications, if selected by Architect. Die-cut vinyl characters are not allowed for room signs / ADA signs / wayfinding signs.

2.2 Plaques

A. Subject to requirements, provide products by or equal to one of the following:
1. Advance Corporation; Braille-Tac Division.
4. Matthews International Corporation; Bronze Division.
5. Metal Arts; Div. of L&H Mfg. Co.

B. Provide etched plaques, as follows:

1. Plaque Material: Aluminum.
2. Color(s): As selected by Architect from manufacturer’s full range.
4. Thickness: 0.125 inch, 0.250 inch thick.

2.3 Dimensional Characters

A. Subject to compliance with requirements, provide products by or equal to one of the following:

1. ACE Sign Systems, Inc.
2. Advance Corporation; Braille-Tac Division.
4. Innerface Sign Systems, Inc.
5. Metal Arts; Div. of L&H Mfg. Co.

B. Produce cast characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.

2. Color(s): As selected by Architect from manufacturer’s full range.

C. Aluminum Extrusions:

1. Finish: Anodized or fluoropolymer coated as selected by Architect.
2. Color(s): As selected by Architect from manufacturer’s full range.

D. Form channel characters with exposed faces and sides with surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories. Comply with the following requirements:

1. Illuminated Channel Characters: Transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
   a. Finish: Anodized or fluoropolymer coated as selected by Architect.
   b. Color: As selected by Architect from manufacturer’s full range.

2. Aluminum Sheet: Not less than 0.090 inch thick.
   a. Finish: Anodized or fluoropolymer coated as selected by Architect.
   b. Color: As selected by Architect from manufacturer’s full range.

3. Bronze Sheet: Not less than 0.032 inch thick.
4. Brass Sheet: Not less than 0.032 inch thick.
5. Copper Sheet: Not less than 0.032 inch, 0.048 inch thick.
6. Steel Sheet: Not less than 0.050 inch thick for face and 0.031 inch thick for returns.
a. Color and Finish: As selected by Architect from manufacturer’s full range.

7. Stainless-Steel Sheet: Not less than 0.050 inch thick.
   a. Finish: No. 4.
   b. Grade: 316 / 316L.

8. Provide manufacturer's hardware for projection mounting of backlit channel letters.
9. Provide translucent acrylic face sheet of thickness indicated.
   a. Color: As selected by Architect from manufacturer’s full range.

E. Molded Plastic Characters: Thermoformed or injection molded, as selected by Architect and as follows:
   1. Illuminated Characters: Transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
   2. Integral Color: As selected by Architect from manufacturer’s full range.

F. Cutout Characters: Provide characters with square-cut, smooth, or eased edges, as selected by Architect. Comply with the following requirements:

   1. Acrylic: 0.25 inch thick.
      a. Metal face laminated to acrylic base.
         1) Stainless-Steel Face: No. 4 finish.
      b. Color: As selected by Architect from manufacturer’s full range.

   2. Aluminum Sheet: 0.125 inch thick.
      a. Finish: Anodized or fluoropolymer coated as selected by Architect.
      b. Color: As selected by Architect from manufacturer’s full range.

   3. Brass Sheet, Yellow: 0.125 inch thick.
   4. Bronze Sheet: 0.125 inch thick.
   5. Vinyl: Pressure sensitive, 3.5 mils thick, if selected by Architect.
      a. Color: As selected by Architect from manufacturer’s full range.


2.4 Signs and Graphics

A. Raised characters shall comply with CBC Section 11B-703.2:

   1. Depth: It shall be 1/32-inch minimum above their background and shall be sans serif uppercase and duplicated in Braille.

   2. Height: It shall be 5/8-inch minimum and 2-inches maximum based on the height of the uppercase letter “I”. CBC Section 11B-703.2.5.
3. Finish and Contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background or dark characters on a light background. CBC Section 11B-703.5.1.

4. Proportions: It shall be selected from fonts where the width of the uppercase letter “O” is 60% minimum and 110% maximum of the height of the uppercase letter “I”. Stroke thickness of the uppercase letter “I” shall be 15% maximum of the height of the character. CBC Sections 11B-703.4 and 11B-703.6.

5. Character Spacing: Spacing between individual tactile characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8.

6. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3 and 11B-703.4. Braille dots shall have a domed and rounded shape and shall comply with CBC Table and Figure 11B-703.3.1.

7. Mounting Height: A tactile sign shall be located 48-inches-minimum to the baseline of the lowest Braille cells and 60-inches-maximum to the baseline of the highest line of raised characters above the finish floor or ground surface.

8. Mounting Location: A tactile sign shall be located on the approach side, as one enters or exits rooms or space, and be reached within 0-inches of the required clear floor space per CBC Section and Figure 11B-703.4.2 as follows:
   a. A clear floor space of 18-inches x 18-inches minimum, centered on the tactile characters, shall be provided beyond the arc of any door swings between the closed position and 45-degree open position.
   b. On the wall at the latch side of a single door.
   c. On the inactive leaf of a double door with one active leaf.
   d. On the wall at the right side of a double door with two active leafs.
   e. On the nearest adjacent wall where there is no wall space at the latch side of a single door or no space at the right side of a double door with two active leafs.

9. Exclusions: No vinyl characters or symbols.

B. Visual characters shall comply with CBC Section 11B-703.5 and shall be 40-inches-minimum above finish floor or ground.

C. Pictograms shall comply with CBC Section 11B-703.6.

D. Symbol of accessibility shall comply with CBC Section 11B-703.7.

2.5 Panel Signs

A. Subject to requirements, provide products by, or equal to, one of the following:
   1. ACE Sign Systems, Inc.
   2. Advance Corporation; Braille-Tac Division.
   3. APCO Graphics, Inc.
   4. ASI-Modulex, Inc.
   5. Best Sign Systems Inc.
B. Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:

1. Aluminum Sheet: 0.080 inch thick.
2. Laminated, Aluminum Faced Sheet: 0.020-inch-thick aluminum sheet laminated to each side of 0.394-inch-thick, phenolic backing.
3. Laminated, Polycarbonate Faced Sheet: 0.060-inch-thick, polycarbonate face sheet laminated to each side of 0.394-inch-thick phenolic backing.
4. Acrylic Sheet: 0.080 inch thick.
5. PVC Sheet: 0.080-inch-thick, extruded, high-impact PVC plastic in color to match face color.
6. High-Pressure Decorative Laminate: 0.048 inch thick.
7. Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face layer, and base-layer thicknesses, respectively, of 0.080 inch.
8. Laminated Sheet: High-pressure engraved stock with contrasting color face laminated to acrylic core as selected by Architect from manufacturer’s full range.
9. Laminated, Etched Photopolymer: Raised graphics with Braille 1/32 inch above surface with contrasting colors as selected by Architect from manufacturer’s full range and laminated to acrylic back.
10. Laminated, Sandblasted Polymer: Raised graphics with Braille 1/32 inch above surface with contrasting colors as selected by Architect from manufacturer’s full range and laminated to acrylic back.
12. Color: As selected by Architect from manufacturer’s full range.
13. No vinyl applied characters or symbols.

2.6 Anchors and Fasteners

A. Use non-ferrous concealed fasteners to as great an extent as possible. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish. Exposed fasteners shall be flat head Phillips type anchors set flush.

B. Provide 3M Scotch Brand foam double sided tape. Foam tape shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 5 mil green flatstock treated with silicone. Foam pads shall be sized for the signs as per signs manufacturer’s recommendations.

C. Provide Dow-Corning No. 999-A silicon adhesive. Adhesive shall be transparent, long aging, high tech formulation.

D. Provide non-corrosive fasteners, hangers, and mounting devices which are compatible with sign material and finish. All fasteners shall be tamper proof type.

E. Other materials not specifically described but required for a complete and proper installation of signs, shall be as reviewed.

F. Use toothed steel or lead expansion bolt devised for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

G. Provide matching backer board if sign is applied to glass panels.
2.7 Accessories

A. Provide nonferrous-metal or hot-dip galvanized anchors and inserts for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors.

2.8 Fabrication

A. General: Provide manufacturer's standard signs of configurations indicated.

1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welded surfaces behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.

2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.

3. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

B. Metal surfaces shall be cleaned, primed, and given a factory or shop applied semi-gloss baked enamel or two-component acrylic polyurethane finish in accordance with NAAMM “AMP 505” with total dry film thickness not less than 1.2 mils.

C. Surface texture of signs shall be matte in accordance with ADA standards.

D. Work shall be assembled in the shop, insofar as practicable, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable. Items specified to be galvanized shall be by hot-dip process after fabrication if practicable. Galvanizing shall be in accordance with ASTM A 123 and ASTM A 525, as applicable. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

E. Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

PART 3 - Execution

3.1 Inspection

A. Examine foundations, walls, doors, ceilings, and other area scheduled to receive signs for conditions that would affect quality and execution of work.

B. Do not proceed with installation until defects are corrected. Proceeding with work constitutes contractor’s acceptance of conditions.

3.2 Installation

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance. Signs on finished surfaces shall not be installed until finishes on such surfaces have been installed and fully cured and dried. Comply with ADA requirements for mounting heights of signs. Conform to layout information on reviewed shop drawings.
and as indicated on Drawings. Locate signs to coordinate with joints and panel edges of substrate construction.

B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.

1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
3. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
4. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials (with same outline border as sign).
5. Mount signs so a person may approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
6. Use 3M VHB tape to mount signs to smooth, nonporous surfaces.
7. Use liquid silicone adhesive recommended by the sign manufacturer to attach units to irregular, porous, or fluoropolymer covered surfaces. Use methods recommended by the sign manufacturer to hold the sign in place until the adhesive has fully cured.
8. Provide concealed aluminum shim plates 1/8 inch thick, with predrilled and countersunk holes, at locations indicated and where other mounting methods are not practicable. Attach the plate with fasteners and anchors suitable for secure attachment to the substrate. Attach panel sign units to the plate using the method specified above.
9. Mount letters with backs in contact with the wall surface unless otherwise directed.

C. Mount dimensional characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.

D. Mount cast-metal plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.

3.3 Protection and Cleaning

A. The work shall be protected against damage during construction. Sign surfaces shall be cleaned in accordance with the manufacturer’s approved instructions.

END OF SECTION 10 14 00
SECTION 10 22 39 - Folding Panel Partitions

PART 1 - General

1.1 Related Documents

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

B. Related Sections:

1. Section 05 12 00 “Structural Steel.”
2. Section 05 40 00 “Cold-Formed Metal Framing.”
3. Section 07 92 00 “Sealants.”
4. Section 08 71 00 “Door Hardware.”
5. Section 08 80 00 “Glazing.”
6. Section 09 22 16 “Non-Structural Metal Framing.”
7. Section 09 29 00 “Gypsum Board.”
8. Section 09 53 23 “Suspended Ceilings.”
9. Section 09 65 00 “Resilient Flooring.”
10. Section 09 68 00 “Carpet.”
11. Section 09 90 00 “Painting.”
12. Division 26 Electrical Sections.

1.2 Definitions

A. NRC: Noise Reduction Coefficient.

B. STC: Sound Transmission Class.

1.3 Performance Requirements

A. Design folding panel partitions, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design folding panel partitions to remain in place without separation of any parts from the system when subjected to the seismic forces determined according to SEI/ASCE 7.

C. Provide folding panel partitions demonstrating the following acoustical properties according to test methods indicated:

1. Sound-Transmission Requirements: Provide folding panel partition assembly rated for not less than STC 51 per ASTM E 413.

D. Laboratory acoustical performance of the folding panel partition wall shall have been conducted in an independent acoustical laboratory in accordance with ASTM E 90 test procedure, and shall have demonstrated an STC rating of no less than 51. A written test report by the test facility shall be available upon request. Verify in writing on manufacturer’s letterhead that the surrounding construction will satisfy and provide the STC rating as specified.
1.4 Submittals

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work, including attachment to actual beams and supporting structure installed as work of other sections. Include details of track, trolleys, hardware, etc. Indicate loading to be imposed in the supporting structure. Show all anchorage, accessory items, caulking, and finishes. Provide reflected ceiling plans, and large scale sections and details of actual conditions, 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. For installed products indicated to comply with design loads, include structural analysis data for attachments, signed and sealed by the qualified professional engineer responsible for their preparation.
2. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
3. Include wiring diagrams for power, signal, and control wiring.
4. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
5. Include wiring diagrams for power, signal, and control wiring.
6. For installed products indicated to comply with design loads, include structural analysis data for attachments, signed and sealed by the qualified professional engineer responsible for their preparation.
7. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.

C. Samples: For each type of exposed material, finish, covering, or facing, trims, tracks and hardware indicated, prepared on samples of size indicated below:

1. Textile: Full width by not less than 24-inch-long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
2. Panel Facing Material: Manufacturer's standard-size unit, not less than 12 inches square.
3. Panel Edge Material: Not less than 12 inches long.
4. Chair Rail: Manufacturer's standard-size unit, 12 inches long.
5. Glass: Units 12 inches square.
6. Hardware: Manufacturer's standard exposed door-operating device.
7. Metal Trim and Exposed Track: 12 inches long.
D. Delegated-Design Submittal: For folding panel partitions indicated to comply with structural performance requirements, provide analysis data and calculations signed and sealed by the qualified professional structural engineer responsible for their preparation.

1.5 Quality Assurance

A. Provide local installer trained and licensed by folding panel partition manufacturer. Local installer is required to insure prompt project coordination and future customer service. Installer shall have a minimum of five years of verifiable experience installing folding panel partitions. Installer shall only use mechanics thoroughly trained in installation of the acoustical folding panel partition wall system provided.

B. Provide the services of a qualified manufacturer’s representative who shall advise the installer and inspect and report on the installation.

C. For products with wood, wood veneers, and wood-based panel products, provide wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

D. Provide panels with finishes meeting the following fire-test-response characteristics per ASTM E 84:

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

E. Provide 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.

F. Conduct pre-installation meeting to comply with requirements in section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

G. In addition to complying with required codes and regulations, comply with all pertinent recommendations contained in the following:

1. California Building Code (CBC), Section 601.5.3.
4. ASTM E 413, “Standard Classification for Sound Transmission Class.”

H. Twenty percent of scheduled value of folding panel partition work shall be retained until folding panel partitions achieve specified field NIC rating and are demonstrated to not exceed maximum operable force requirements.

1.6 Delivery, Storage, and Handling

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels. Do not bring panels onto site until building is enclosed and environmental systems are turned on.

B. In the event of damage, immediately make all repairs and replacements necessary, at no change in Contract Time or Contract Sum.
C. Do not deliver or unpackage folding panel partitions until space has been enclosed and is weather tight, until wet work in the space has been completed, and until the ambient conditions of temperature and humidity are near those values indicated for final occupancy.

1.7 Project Conditions

A. Verify actual dimensions of folding panel partition openings by field measurements before fabrication. Coordinate with necessary trades to establish dimensions.

1.8 Warranty

A. Provide warranty in which manufacturer agrees to repair or replace components of folding panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Faulty operation of folding panel partitions.
   b. Deterioration of metals, metal finishes, and other materials beyond normal wear.
   c. Deterioration of panel finishes beyond normal wear.

2. Warranty Period: 10 years.

PART 2 - Products

2.1 Materials

A. Steel sheet, 0.0747-inch nominal minimum thickness for uncoated steel.

B. Steel Face/Liner Sheets: Tension-leveled steel sheet, 0.047-inch nominal minimum thickness for uncoated steel.

C. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B 221 for extrusions; manufacturer's standard strengths and thicknesses for type of use.

D. Provide aluminum frame reinforcement.

E. Gypsum Board: ASTM C 36.

F. Plywood: DOC PS 1.

G. Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde.

H. Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde.

2.2 Folding Acoustical Panels

A. Provide folding acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.

1. Provide Hufcor Series 632 or equal to, the following:

b. Modernfold, Inc.; a DORMA Group Company  
c. Panelfold, Inc.

B. Panel Operation: Manually operated, paired panels.

C. Panel Operating Force: Paired panel force is eleven (11) pounds to operate the panel.

D. Provide top reinforcement panel construction as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

E. Dimensions: Fabricate folding acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements. Panel Width: Equal widths.

F. STC: Not less than 50.

G. NRC: Per ASTM C 423.

H. Panel Weight: 12 lb./sq. ft. maximum.

I. Panel Thickness: Not less than 3 inches.

J. Panel Closure: Manufacturer's standard.
   1. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal.

K. Provide hardware as required to operate folding panel partition and accessories; with decorative, protective finish.
   1. Hinges: Concealed (invisible).

2.3 Seals

A. Provide types of seals that produce folding panel partitions complying with acoustical performance requirements and seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between folding panel partition perimeter and adjacent surfaces, when folding panel partition is extended and closed.

B. Vertical Seals: Deep-nesting, interlocking steel astragals mounted on each edge of panel, with continuous extruded-PVC seal. Exerting continuous pressure when end panels are pressed into receiving jamb.

C. Horizontal Top Seals:
   1. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.
   2. PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.

D. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting
panel movement. Automatic operation of extension and retraction of bottom seal by movement of partition, with operating range not less than 1-1/2 inches between retracted seal and floor finish.

2.4 Finish Facing

A. Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to folding panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.

1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, and with no gaps or overlaps. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
2. Match facing pattern 72 inches above finished floor.
3. Color/Pattern: As selected by Architect from manufacturer's full range of colors and patterns including custom colors and patterns.

B. Provide mildew-resistant, washable, vinyl-coated fabric wall covering; complying with CFFA-W-101-D for type indicated; Class A with additives capable of inhibiting growth of bacteria, fungi, and yeasts.

C. Provide nonwoven, needle-punched carpet with fibers fused to backing carpet wall covering, from same dye lot, treated to resist stains.

D. Provide 100 percent polyolefin woven fabric wall coverings, from same dye lot, treated to resist stains.

E. Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 Suspension Systems

A. Provide steel suspension tracks mounted to overhead structural support, with adjustable steel hanger rods, designed for type of operation, size, and weight of folding panel partition indicated. Size track to support partition operation and storage without damage to suspension system, folding panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

1. Panel Guide: Aluminum; finished with factory-applied, decorative, protective finish. Isolate from steel support assembly.
2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.

B. Provide trolley system carriers as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

1. Provide multidirectional carriers capable of negotiating 90-degree L, T, and X intersections without track switches.

C. Track Intersections, Switches, and Accessories: As required for type of operation, storage, track configuration, and layout indicated for folding panel partitions and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.

1. Curve-and-Diverter Switches: Allowing radius turns to divert panels to an auxiliary track.
2. L Intersections: Allowing panels to change 90 degrees in direction of travel.
3. **T Intersections**: Allowing panels to pass through or change 90 degrees to another direction of travel.

4. **X Intersections**: Allowing panels to pass through or change travel direction full circle in 90-degree increments, and allowing 1 partition to cross track of another.

5. **Multidirectional Switches**: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.

6. **Center carrier stop**.

7. **D. Aluminum Finish**: Class I, anodizing; color selected by Architect from manufacturer’s full range of colors.

8. **E. Steel Finish**: Shop prime and powder-coat; color selected by Architect from manufacturer’s full range of colors including custom colors.

### 2.6 Pocket Door

**A.** Provide Type 2 pocket door(s) as manufactured by Hufcor, Inc.

1. Pocket door(s) shall be nominally 3-inches-thick.
2. Panel faces shall be laminated to appropriate substrate to meet the STC requirement. STC rating shall be determined by the partitions selected for use with the pocket doors.
3. Frames shall be of 16 gauge painted steel with integral factory applied aluminum vertical edge and face protection.
4. Pocket doors at heights of 16’-3” and over, without face steel, will have horizontal splice rail(s). Location and quantity of splice rails is dependent upon height of door.
5. Horizontal top and bottom seals shall be of continuous contact multi-ply vinyl sweepstrips. When the pocket doors are in the closed position, the seals shall contact an aluminum head member which extends across the pocket from the track to the pocket walls.
6. Pocket doors shall be secured in the closed position by the face-activated expanding internal mechanism.
   a. The operating mechanism is to be located approximately 46-inches from the floor in the door face.
   b. The top mechanism extends from the top rail of the pocket door and latches in the horizontal header.
   c. A jamb plate shall be attached to the floor to capture the bottom mechanism.
7. Hinges shall be of steel and project no more than 1/4-inch beyond panel faces. Each pocket door “leaf” to have a minimum of four hinges.
8. Jambs shall be of 6063-T6 aluminum and be adjustable plus/minus 3/8-inch.

**B.** Weight of the pocket doors shall be 5.7-8.9 lbs. per sq. ft. based on sound rating of the partition selected.

**C.** Finishes

1. Face finish shall be unfinished for field painting.
2. Exposed metal trim, jambs, and seal color shall be Gray (standard).

**D.** Available Accessories/Options

1. Key lock – one side.

**E.** Operation: Pocket doors shall be manually opened and closed.
PART 3 - Execution

3.1 Examination

A. Examine flooring, structural support, adjacent walls and framing, ceilings and openings, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of folding panel partitions. Verify deflection amount of supporting structure. Deflection of structural support under maximum anticipated load shall be no greater than 0.125 inches in 12 feet.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of substrate conditions by Contractor.

3.2 Installation

A. Comply with ASTM E 557 except as otherwise required by folding panel partition manufacturer's written installation and warranty requirement. Provide a complete operable installation.

B. Install folding panel partitions and accessories after other finishing operations, including painting, have been completed.

C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

F. Track and panels shall be installed plumb level and true to building lines within 1/8 inch in 10 feet.

G. Install partition to provide quiet, smooth, easily moving operation without warp or bind. Adjust panels to move evenly and parallel. Ensure that panels will stay firmly in storage location when fully open.

3.3 Adjusting

A. Adjust folding panel partitions to operate smoothly, without warping or binding. Lubricate hardware, and other moving parts.

B. Adjust storage pocket doors to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.4 Field Quality Control

A. Prior to acoustical tests, conduct operational test and demonstration of folding panel partition, in the presence of Inspector of Record and partition manufacturer’s representative.

1. Demonstrate that each panel will operate throughout track system, from storage to and from extended position, without requiring in excess of 25 pounds horizontal static force applied approximately 48 inches above finish floor.

2. Force may be applied at one point or distributed between two points.

3. Should system fail to attain minimum requirements, corrections shall be made by contractor and tests conducted again. Process shall be repeated until specified maximum operating force is achieved.
4. Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.

B. Within 60 days of completion of installation, field test shall be conducted by Owner’s independent testing and inspection agency.

1. Folding panel partition installation shall be tested according to ASTM E 336 for compliance with specified NIC rating. The NIC rating shall be calculated according to ASTM E 413.
2. Prior to testing, the independent testing and inspection agency shall examine flanking paths to determine that they will not significantly affect performance of folding panel partitions.
3. Authorized representative of manufacturer shall observe testing and direct or make adjustments to products as necessary.
4. Should system fail to attain minimum requirements, corrections shall be made by contractor and tests conducted again. Process shall be repeated until specified NIC rating is achieved, adjusted for field conditions such as minor flanking acoustical paths.

C. Repair or replace folding panel partitions that do not comply with requirements.

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

E. Prepare test and inspection reports.

3.5 Cleaning and Protection

A. Clean soiled surfaces of folding panel partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

B. Protect panel partitions until time of completion by storing panels in stacked configuration with protective cover.

3.6 Demonstration

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

END OF SECTION 10 22 39
SECTION 10 26 23 - Impact-Resistant Wall Protection

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 08 71 00 “Door Hardware.”
2. Section 09 22 16 “Non-Structural Metal Framing.”
3. Section 09 29 00 “Gypsum Board.”

1.2 Performance Requirements

A. Provide wall protection units with surface burning characteristics as determined by ASTM E 84 with a smoke development of 350-450 and flame spread of 10.

B. Provide rigid vinyl profile materials that have an impact strength of 30.2 ft. lbs./inch of thickness as tested in accordance with the procedures specified in ASTM D 256-90b, Impact Resistance of Plastics.

C. Provide end wall protectors that show resistance to stain when tested in accordance with applicable provisions of ASTM D 543.

D. Provide rigid vinyl that does not support fungal or bacterial growth as tested in accordance with ASTM G 21 and ASTM G 22.

E. Provide components matched in accordance with SAEJ-1545 (Delta E) with a color difference no greater than 1.0 units using CIE Lab, CIE CMC, CIE LCh, Hunter lab or similar color space scale systems.

1.3 Submittals

A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each type of impact-resistant wall-protection device and accessory.

B. Shop Drawings: Show locations and extent. Include sections, details, and attachments to other work. Show finishes and backings in details.

C. Samples: For each type of exposed wall protection device, finish, and color required, sizes indicated below.

1. Wall and Corner Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.

1.4 Quality Assurance

A. Provide installer and workers trained and approved by manufacturer.

B. Obtain impact-resistant wall-protection units through one source from a single manufacturer.
C. Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall-protection units and are based on the specific system indicated. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Provide impact-resistant, plastic wall-protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

E. Before beginning actual work, install mockups of at least 8’ x 8’ in surface area to demonstrate aesthetic effects and set quality standards for materials and execution. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of wall protection device, finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
   a. Inside and outside corners.
   b. End wall condition.
   c. End of wall protection.
   d. Transitions to other finish materials.
   e. Reveals in finish materials.
   f. Sealants.
   g. Sheathing, framing and substrates.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

F. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.5 Delivery, Storage, and Handling

A. Deliver materials in unopened factory packaging to the jobsite.

B. Inspect materials at delivery to assure that specified products have been received.

C. Store impact-resistant wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
1. Maintain room temperature within storage area at not less than 70° F during the period plastic materials are stored.
2. Keep plastic sheet material out of direct sunlight.
3. Store plastic wall-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70° F.
5. Store wall-guard covers in a horizontal position.

1.6 Project Conditions

A. Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70° F for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings. If field dimensions are not available, coordinate with appropriate trades to determine dimensions.

1.7 Coordination

A. Coordinate with other trades including framing prior to application of finishes and substrates to assure proper location for backing for attachment and support of wall protection devices.

1.8 Warranty

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Deterioration of plastic and other materials beyond normal use.
   c. Attachment failures.
   d. Color fading.

2. Warranty Period: Lifetime of building.

1.9 Extra Materials

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Guard Covers: Full-size plastic covers of maximum length equal to 2% of each type, color, and texture of units installed, but no fewer than two, 8-foot-long units.
2. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 2 % of each type, color, and texture of units installed, but no fewer than five, 4-foot-long units.
3. End Caps for Wall and Corner Guards: Provide 6 of each type.

B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.
PART 2 - Products

2.1 Materials

A. Provide extruded rigid plastic ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; thickness as indicated.

1. Impact Resistance: Minimum 25.4 ft-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
2. Chemical and Stain Resistance: Tested according to ASTM D 543.
3. Self-extinguishing when tested according to ASTM D 635.
4. Flame-Spread Index: 25 or less.
5. Smoke-Developed Index: 450 or less.

B. Provide aluminum extrusions of alloy and temper recommended by manufacturer for type of use and finish indicated but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.

C. Stainless-Steel Sheet: ASTM A 240.


E. Provide aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened and with substrate conditions. Use security-type fasteners where exposed to view.

2.2 Wall Guards

A. Provide all rigid vinyl rubrail and wall protection from a single source.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. ARDEN Architectural Specialties, Inc.
   b. Balco, Inc.
   c. Construction Specialties, Inc.
   d. InPro Corporation.
   e. Korogard Wall Protection Systems; Division of RJF International Corporation.

2. Rubrails: Rigid Vinyl Rubrail Options:
   a. Thickness: R8 0.80” = 5/64” – available.
   c. Height: 12”
   d. Length: 8’

3. Vinyl: Rubrails shall be manufactured from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers.

4. Adhesives:
   a. 3M Fastbond Contact Cement, a water dispersed contact cement.
   b. InPro Bond Adhesive, a freeze-thaw stable trowelable adhesive.
   c. XT-2000+ Adhesive, a freeze-thaw stable trowelable adhesive.

2.3 Corner Guards

A. Provide surface-mounted, resilient, plastic corner guard assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated to match wall condition.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. ARDEN Architectural Specialties, Inc.
   b. Balco, Inc.
   c. Construction Specialties, Inc.
   d. InPro Corporation.
   e. Korogard Wall Protection Systems; Division of RJF International Corporation.

2. Provide extruded rigid plastic cover, minimum 0.100-inch wall thickness; in dimensions and profiles indicated on Drawings. Color and texture as selected by Architect from manufacturer's full range including custom colors.

3. Retainer: 0.060-inch-thick minimum, 1-piece, extruded aluminum.

4. Provide prefabricated, injection-molded plastic top and bottom caps; color matching cover; field adjustable for close alignment with snap-on cover.

2.4 End-Wall Guards

A. Provide surface-mounted, resilient, plastic end-wall guard assembly consisting of snap-on plastic cover installed over continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering; including mounting hardware.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. ARDEN Architectural Specialties, Inc.
   b. Balco, Inc.
   c. Construction Specialties, Inc.
   d. InPro Corporation.
   e. Korogard Wall Protection Systems; Division of RJF International Corporation.

2. Provide extruded rigid plastic cover, minimum 0.100-inch wall thickness; in dimensions and profiles indicated on Drawings. Color and texture as selected by Architect from manufacturer's full range including custom colors.

3. Retainer: Minimum 0.060-inch-thick, 1-piece, extruded aluminum.

4. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.5 Fabrication

A. Fabricate impact-resistant wall-protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

B. Preform curved semirigid, impact-resistant sheet wall covering in factory for radius and sheet thickness as follows:

1. Sheet Thickness of 0.040 Inch Minimum: 24-inch radius.
2. Sheet Thickness of 0.060 Inch Minimum: 36-inch radius.
C. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

D. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - Execution

3.1 Examination

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

2. For impact-resistant wall-protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes contractor’s acceptance of substrate conditions.

3.2 Preparation

A. Complete all finishing operations, including painting, before installing impact-resistant wall-protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 Installation

A. Install impact-resistant wall-protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work. Install impact-resistant wall-protection units in locations and at mounting heights indicated on Drawings or, if not indicated, at heights indicated below:

B. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.

1. Provide anchoring devices to withstand imposed loads.

2. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches.

3. Adjust end, top, and bottom caps as required to ensure tight seams.

C. Miter corners and ends for returns.

D. Provide top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 Cleaning

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.
SECTION 10 28 16 - Toilet and Bath Accessories

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 05 40 00 “Cold-Formed Metal Framing.”
   2. Section 08 80 00 “Glazing.”
   3. Section 09 11 16 “Non-Structural Metal Framing.”
   4. Section 09 29 00 “Gypsum Board.”
   5. Section 09 30 00 “Tile.”
   6. Division 26 Electrical Sections.

1.2 Regulatory Requirements

A. All accessories shall be mounted at locations in compliance with CBC Sections 11B-602 through 11B-612.

B. Grab bars shall comply with CBC Section 11B-609.

C. Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges. The space around the grab bars shall be as follows:
   1. 1-1/2-inches minimum between the grab bar and the wall.
   2. 1-1/2-inches minimum between the grab bar and projecting objects below and at the ends.
   3. 12-inches minimum between the grab bar and projecting objects above.

1.3 Submittals

A. Product Data: For each type of product indicated. Include the following:
   1. Construction details and dimensions.
   2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Material and finish descriptions.
   4. Features that will be included for project.
   5. Manufacturer's warranty.
   6. Recommended mounting heights to comply with accessible requirements.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements. Approved full-size samples will be returned and may be used in the work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Identify locations using room designations indicated on Drawings. Identify products using designations indicated on Drawings.
1.4 Quality Assurance

A. For each kind of product, provide products of same manufacturer unless otherwise approved by Architect in writing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Before beginning actual work, install mockups of each type of toilet and bath accessory to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of accessory and each surrounding finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:
   a. Finishes.
   b. Accessories.
   c. Fasteners.
   d. Underlayments.
   e. Sealants.
   f. Sheathing, framing and substrates.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.

4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

D. Conduct pre-installation meeting to comply with requirements in Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.5 Coordination

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Verify anchoring requirements for substrate conditions and manufacturer’s recommendations. Furnish appropriate fasteners for project conditions. Furnish backing information and templates for cutouts for proper layout and installation of supporting construction. Deliver templates, dimensions, inserts and anchoring devices set into concrete or masonry as required to prevent delaying the work.
C. Coordinate with wall framing prior to covering of framing to assure rough openings are properly sized and located and that adequate blocking and backing are provided for support and attachment of accessories.

D. Coordinate with electrical trades prior to enclosure of rough in work to assure adequate electrical power and circuiting is provided and properly located to accessories.

E. Coordinate with framing, drywall and tile trades prior to enclosure of framing to assure that recessed accessories will have sufficient size and depth of rough opening to allow proper installation.

1.6 Product Delivery, Storage and Handling

A. Deliver items in manufacturer’s original unopened packaging with attached labels, and store under protective cover until installed. Where accessories are furnished with strippable coatings, leave coatings intact until final acceptance.

1.7 Warranty

A. Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period. Warranty Period: 15 years.

PART 2 - Products

2.1 Basis of Design

A. Products listed below are to establish design aesthetic, material quality and performance criteria only. Model numbers are based on Bobrick washroom equipment and are not intended to be exclusive. Do not change design aesthetic without written authorization from Architect.

1. Provide screws, bolts, and other devices of same material as accessory unit and tamper and theft resistant where exposed, and of stainless steel in all locations. Provide concealed fasteners and mounting whenever possible.
2. Provide mirror glass that complies with ASTM C 1503, nominal 1/4-inch-thick.

2.2 Public-Use Washroom Accessories

A. Subject to requirements, provide products as shown on the Drawings.

2.3 Underlavatory Guards

A. Subject to requirements, provide products by one of, or equal to, the following:

1. Plumberex Specialty Products, Inc.
2. TCI Products.
3. Truebro, Inc.

B. Provide tight fitting, antimicrobial, white, molded plastic, smooth, monolithic insulating pipe covering on supply and drain piping to allow access to plumbing facilities and prevent contact with and burns from hot pipes.

C. Provide manufacturer’s flush fasteners for attachment and flap cap access covers to allow access to valve handles and P-trap cleanout. The insulating material shall be 1/8 inch thick molded closed cell vinyl, shall conform to all ADA requirements, and shall be self extinguishing. Thermal conductivity (K) of the
material shall be 1.17 BTU in/hr/sf/deg. F. The assemblies shall be designed to fit snugly over the pipes, valves and trap, shall cover the units completely, and shall extend to the back wall. Units shall meet or exceed the following requirements:

<table>
<thead>
<tr>
<th>Physical Property, Units</th>
<th>Test Method</th>
<th>Acceptable Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-bacterial</td>
<td>ASTM G 21</td>
<td>No measurable growth</td>
</tr>
<tr>
<td>Anti-fungal</td>
<td>ASTM G 22</td>
<td>No measurable growth</td>
</tr>
<tr>
<td>Burning</td>
<td>ASTM D 635</td>
<td>Less than 5 seconds</td>
</tr>
<tr>
<td>Thermal conductivity, BTU, in/hr/ft2/deg. F</td>
<td>ASTM C 177 in/hr/ft2/deg. F</td>
<td>1.02</td>
</tr>
</tbody>
</table>

2.4 Fabrication

A. Fabricate units with tight seams and joints, and exposed edges and corners rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates and concealed fasteners.

B. Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of 3 keys per unit to Owner’s representative.

C. Recessed accessories shall have seamless one piece flange on exposed face. Weld all corners, leave no open miters.

D. All receptacles and storage containers shall be fabricated of Type 304 stainless steel. Series 400 stainless steel is not acceptable.

E. All edges, both exposed and concealed, shall be ground smooth. Rough edges on any part of the accessories will be cause for rejection.

F. Use continuous piano hinges on doors.

G. Accessories specified or furnished with key locks (tumbler locks) shall be keyed alike, except that key coin boxes of coin operated dispensing units shall be keyed differently.

2.5 Fasteners

A. Provide concealed fasteners to greatest extent possible.

B. Provide stainless steel fasteners throughout.

C. Provide galvanized steel ASTM A 386 mounting devices.

D. Provide tamper resistant fasteners at exposed conditions.
PART 3 - Execution

3.1 Inspection

A. Verify that openings to receive accessories are constructed to correct size, and are plumb, level, and in alignment with other items so indicated. Verify that surfaces to receive accessories are in alignment, so that installed accessories will be flat, level, plumb, fitted snugly against adjoining surfaces without gaps. Field verify that all proper stud backing and stud framing supports are in place prior to any installation.

B. Correct all deficiencies prior to beginning work. Starting work constitutes contractor’s acceptance of substrate and surrounding conditions.

3.2 Installation

A. Install accessories according to manufacturers’ written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units square, level, plumb, and firmly mechanically anchored in locations and at heights indicated. Use concealed fasteners and anchoring whenever possible. Exposed fasteners shall be tamper proof.

B. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

C. Drill holes to correct size and application so that it is concealed by item with 1/4 inch tolerance.

D. Mount recessed accessories into wall openings with sheet metal screws into metal frames.

E. Fasten surface mounted accessories to backing plates with machine screws, plumb and align.

F. Install manufacturer’s recommended anchorage system for all grab bars.

G. Fit flanges of accessories snug to wall surfaces. Seal gaps between flanges and finish wall surfaces after accessories are installed with clear single component silicone sealant.

H. Install accessories after room finishes such as plaster, painting and tile work have been completed. Install recessed elements before finish work. Secure accessories to substrate with all vertical lines plumb and all horizontal lines level.

I. Maintain acoustical integrity of walls by filling cavity around box with unfaced fiberglass insulation or by applying electrical outlet box acoustical sheeting to the back, top, bottom and sides.

3.3 Adjusting and Cleaning

A. Adjust accessories for unencumbered, smooth operation. Protect accessories from damage and soiling. Prohibit use of accessories during the work. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer’s written recommendations.

END OF SECTION 10 28 16
SECTION 10 44 00 - Fire-Protection Specialties

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 05 40 00 “Cold-Formed Metal Framing.”
   2. Section 07 84 00 “Through-Penetration Firestop Systems.”
   3. Section 07 92 00 “Sealants.”
   4. Section 08 80 00 “Glazing.”
   5. Section 09 22 16 “Non-Structural Metal Framing.”
   6. Section 09 29 00 “Gypsum Board.”
   7. Section 09 30 00 “Tile.”
   8. Section 09 90 00 “Painting.”
   9. Section 10 14 00 “Signage.”
  10. Division 21 Fire Suppression Systems.

1.2 Submittals

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for security fire-protection cabinets.
   1. Fire Extinguishers: Include rating and classification.
   2. Security Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
   3. Show location of knockouts for hose valves.

B. Samples: For each type of exposed metal and finish required, 6 by 6 inches square.

1.3 References

A. Fire Extinguishers Standard: NFPA 10, “Portable Fire Extinguishers.”

B. Title 19, California Code of Regulations (CCR), “Public Safety.”

C. California Fire Code (CFC).

1.4 Quality Assurance

A. Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Provide fire extinguishers listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction. Provide fire extinguishers approved, listed, and labeled by FMG.
D. Conduct pre-installation meeting at Project site. Review methods and procedures related to fire protection cabinets including schedules and coordination requirements.

E. Fire extinguisher cabinets shall comply with CBC Sections 11B-307, 11B-308, 11B-309 and 11B-403.

1.5 Coordination

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers required by fire authority are accommodated.

B. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

C. Coordinate with fire authority on location and spacing of fire extinguisher. Arrange with fire authority to walk project to identify required locations of fire extinguishers, prior to enclosure of framed walls. In addition to quantity shown, review requirements with Fire Authority and provide all fire protection equipment required by Fire Authority.

D. Coordinate with framing, gypsum board and plaster trades prior to covering framing, to assure proper framing blocking, backing, and opening size depth to receive fire protection devices. Assure continuity of fire rated assemblies.

1.6 Warranty

A. Provide manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to failure of hydrostatic test according to NFPA 10, faulty operation of valves or release levers. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide Potter Roemer 1700 Series, or equal.

2.2 Materials

A. Stainless-Steel Sheet: ASTM A 666, Type 304.

B. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1-1/5-inch thick.

2.3 Portable Fire Extinguishers

A. Provide fire extinguishers of type, size, and capacity required by fire authority.

3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated 2-A:10-B:C, 5-lb. nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.
2.4 Fire-Protection Cabinet

A. Non-Rated Cabinet Stainless Steel: Suitable for fire extinguisher.

B. Semirecessed Cabinet: Cabinet box partially recessed in walls with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
   1. Square-Edge Trim: 1-1/4- to 1-1/2-inch wall return depth.
   2. Rolled-Edge Trim: 2-1/2-inch wall return depth.

C. Door and Cabinet Material: Same material as cabinet.

D. Door Style: Fully glazed panel with frame.

E. Door Glazing: Tempered break glass.

F. Provide door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated, and as follows:
   1. Recessed door pull.
   2. Continuous Hinge: Same material and finish as trim, permitting door to open 180 degrees.
   4. Provide steel break-glass strike, complete with chain and mounting clip, secured to cabinet.
   5. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle. Provide 3 keys per lock.
   6. Lettering decals complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by fire authority. Identify fire extinguisher in fire protection cabinet with the words “FIRE EXTINGUISHER.”
   7. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to security fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

G. Finishes:
   1. Stainless Steel: No. 4 finish.

H. Fire Extinguisher Cabinets
   1. Fire Extinguisher Cabinets must comply with CBC Sections 11B-307, 11B-308, 11B-309 and 11B-403.

2.5 Fabrication

A. Fabricate cabinets and components per manufacturer’s written recommendations to comply with Project conditions, styles specified, and fire extinguishing equipment required by fire authority. Verify requirements with fire authority.

B. Provide box (tub) cabinets, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style. Weld joints and grind smooth. Ease and round all edges and sharp corners. Prepare doors and frames to receive locks. Install door locks at factory.
C. Fabricate doors from materials indicated and coordinated with cabinet types and trim styles selected. Fabricate door frames of one-piece construction, with edges flanged. Miter and weld perimeter door frames. Ease and round all edges and sharp corners.

D. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 Fasteners

A. Provide concealed fasteners to greatest extent possible.

B. Exposed fasteners shall be flathead Phillips type anchors finished flush with adjacent surface.

C. Exposed fasteners shall be finished to match adjacent surfaces.

D. Provide stainless steel fasteners.

2.7 Finishes

A. Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are not acceptable.

2.8 Stainless Steel Finishes

A. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

1. Directional Satin Finish: No. 4.
3. Reflective, Directional Polish: No. 7.
4. Mirrorlike Reflective, Nondirectional Polish: No. 8

B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - Execution

3.1 Examination

A. Examine roughing-in for hose cabinets to verify actual locations of piping connections before cabinet installation.

B. Examine walls and partitions while open stages of framing progress and while there is still time to modify framing for suitable framing depth and blocking where recessed, semirecessed, and surface-mounted cabinets will be located and installed. Notify Architect in writing immediately if conflicts are found.
Semirecessed and surface mounted cabinets shall not project more than 4 inches into corridors, passageways or aisles. Coordinate locations of blocking, backing and framing to accommodate cabinets.

C. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with any part of cabinet installation constitutes acceptance of substrate conditions by Contractor.

3.2 Preparation

A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 Installation

A. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction. Install cabinets square, plumb, and level. Securely anchor by mechanical means only using stainless steel fasteners. Conform to installation instructions. Exact locations shall be as indicated or directed.

B. Maintain acoustical integrity of walls by filling cavity around box with unfaced fiberglass insulation or by applying electrical outlet box acoustical sheeting to the back, top, bottom and sides.

C. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

D. Place extinguishers in cabinets and mount extinguishers on brackets on walls at locations indicated on the Drawings and as directed to suit requirements of Fire Marshal. Place fire extinguishers immediately prior to Substantial Completion review or sooner if directed by Fire Marshal.

E. Apply decals at locations required by fire authority.

3.4 Adjusting and Cleaning

A. Remove temporary protective coverings and strippable films, if any, as security fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust security fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of security fire-protection cabinet installation, clean interior and exterior surfaces. Repair/paint wall surfaces to surrounding fire extinguisher cabinets damaged during installation to match existing wall surface.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by security fire-protection cabinet manufacturer.

E. Replace security fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 00
SECTION 11 52 13 - Projection Screens

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:
   1. Section 09 90 00 “Painting.”
   2. Division 26 Sections for electrical service and connections including metal device boxes for switches and conduit, where required, for low-voltage control wiring.

1.2 Definitions

A. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.

B. Gain of Rear-Projection Screens: Ratio of light refracted by screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94, except that for measuring luminance of test screen, projection lamp shall be placed behind screen same distance as it was placed in front of magnesium carbonate surface for measuring luminance of reference standard.

C. Half-Gain Angle: The angle, measured from the axis of the screen surface, to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.3 Submittals

A. Product Data: For each type of screen indicated.

B. Shop Drawings: Show layouts and types of projection screens. Include the following:
   1. Location of screen centerline relative to ends of screen case.
   2. Location of wiring connections.
   3. Location of seams in viewing surfaces.
   4. Drop length.
   5. Connections to supporting structure for pendant- and recess-mounted screens.
   6. Anchorage details.
   7. Details of juncture of exposed surfaces with adjacent finishes.
   8. Frame details.
   10. Wiring Diagrams: For electrically operated units.
   11. Housing and cover panel details.

C. Samples for Initial Selection: For finishes of surface-mounted screen cases.

D. Maintenance Data: For projection screens to include in maintenance manuals.
1.4 Quality Assurance

A. Obtain projection screens and accessories through one source from a single manufacturer with a minimum of 10 years experience in the fabrication of projection screens similar to type specified. Obtain each screen as a complete unit, including necessary mounting hardware and accessories.

B. Provide installer with minimum of 3 years full time experience installing projection screens similar in scope and complexity to that specified. Where applicable, installer shall be certified or acceptable to manufacturer of equipment.

C. Regulatory Requirements:

1. Mounting and installation of projection screen components shall comply with seismic restraint and anchoring requirements of California Building Code (CBC).

D. All projection screen components shall be securely anchored to withstand seismic forces. Standard shall be the criteria required for the building structure or those of authorities having jurisdiction, whichever is more stringent.

E. Coordinate recesses, backing and supports to suit projection screen equipment. Provide access ways for installation, removal and servicing of built-in equipment.

1.5 Project Conditions

A. Comply with environmental requirements and recommendations of projection screen manufacturers under which installation shall be performed including temperature, humidity and dust.

1.6 Delivery, Storage, and Handling

A. Do not deliver projection screens until building is enclosed and weather tight and other construction, including finishes, within spaces where screens will be installed is substantially complete and ready for intended occupancy.

B. Store rear-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.7 Coordination

A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling framing, light fixtures, HVAC equipment, fire-suppression system, partitions and structure. Coordinate for required framing, blocking and backing necessary.

PART 2 - Products

2.1 Front-Projection Screens

A. Provide manual spring-roller-operated screens, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.

1. Provide screen with top edge securely anchored to a 3-inch-diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.

2. Provide units with stainless-steel tab tensioning cables finished black on both sides of screen connected to edges of screen by tabs to pull screen flat horizontally.
B. Provide surface-mounted, metal encased, manually operated screens designed and fabricated for surface mounting on wall or ceiling, fabricated from formed steel sheet not less than 0.027 inch thick or aluminum extrusions; with flat back design and baked-enamel finish. Provide end caps and universal mounting brackets, finished to match end caps.

1. Subject to requirements, provide products by one of, or equal to, the following:
   a. Da-Lite Screen Co., Inc.; Model C.

PART 3 - Execution

3.1 Installation

A. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.

   1. Install low-voltage controls according to NFPA 70 and manufacturer's written instructions. Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
   2. Test electrically operated units to verify that screen controls, limit switches, closure, and other operating components are in optimum functioning condition.
   3. Test manually operated units to verify that screen operating components are in optimum functioning condition.

3.2 Testing

A. Before Substantial Completion demonstrate proper operation by opening and closing each projection screen. Open and close each manual projection screen two times. Demonstrate successful operation of projection screens to satisfaction of Owner. Make necessary adjustments to system to satisfaction of Owner at no additional cost or time to Contract.

3.3 Protecting and Cleaning

A. After installation, protect projection screens from damage during construction. If damage occurs despite such protection, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

END OF SECTION 11 52 13
SECTION 12 24 13 - Roller Shades

PART 1 - General

1.1 Related Documents

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

B. Related Sections include the following:

1. Section 05 40 00 “Cold-Formed Metal Framing.”
2. Section 09 22 16 “Non-Structural Metal Framing.”
3. Section 09 29 00 “Gypsum Board.”
4. Section 09 53 23 “Suspended Ceilings.”

1.2 Submittals

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

1. Motorized Shade Operators: Include operating instructions.
2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

1. Motorized Shade Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
2. Wiring Diagrams: Power, system, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, 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. Ceiling suspension system members and attachment to building structure.
2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
3. Shade mounting assembly and attachment.
4. Size and location of access to shade operator, and adjustable components.
5. Minimum Drawing Scale: 1/8 inch = 1 foot.

D. Samples:

1. Complete, full-size operating unit not less than 16 inches wide for each type of roller shade indicated.
2. For the following products:

   a. Shade Material: Not less than 3 inches square, with specified treatments applied. Mark face of material.
b. Shade Material: Not less than 12-inch-square section of fabric, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.

c. Valance: Full-size unit, not less than 12 inches long.

E. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.

1.3 Quality Assurance

A. Provide installer that is trained, certified and approved by roller shade manufacturer with a minimum of 5 years of experience in installing roller shades similar to those specified.

B. Obtain roller shades through one source from a single manufacturer with a minimum of 10 years of experience manufacturing roller shades similar to those specified.

C. Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Flame-Resistance Ratings: Passes NFPA 701.

D. Provide listed and labeled electrical components, devices, and accessories as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Provide roller shades complying with WCMA A 100.1.

F. Shade cloth to “pass” indoor air Quality / VOC testing as per ASTM D 5116-97 and ASTM D 6670-01, USEPA – ETV (U.S. Environmental Protection Agency’s Environmental Technology Verification Protocol.)

G. Anti-microbial characteristics “no growth” ASTM G 21 results for fungi ATCC9642, ATCC9644, ATCC9645.

H. Use only injection-molded Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based, PVC, or glass reinforced polyester thermo polymer plastics are not acceptable.

I. Before beginning actual work, install mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for each type of roller shade, finish and installation. Construct mockup in a layered fashion to show all elements of the assembly. Include the following:

   a. Wall and ceiling constructions including framing and finishes.
   b. Window openings, frame and glass.
   c. Door openings, frame and door.
   d. Soffit framing and finish.
   e. Screeds, joints, casings and other accessories.
   f. Sealant joints.
   g. Sheathing, framing and substrates.

2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

3. Do not proceed with work until mockup is approved by Architect. Reconstruct mockup as necessary to obtain Architect’s approval.
4. Coordinate with necessary trades to construct mockup to reflect actual construction. Obtain materials, and services of other trades to participate in mockup construction so mockup reflects actual construction and conditions proposed in finished work in all respects, including but not limited to, supporting structure, substrates, flashing, attachment, backings, opening and finished materials. Provide materials identical to materials that will be used in actual work.

5. Architect’s review and comments or no-comment of mockup does not relieve contractor from fulfilling requirements of Contract Documents. Deviations from Contract requirements in completed work whether noted or not noted in mockup are contractor’s responsibility and must be corrected at no additional cost or time to Contract.

6. Use workers trained and experienced in each particular trade required to construct each element of the mockup.

J. Conduct pre-fabrication meeting at project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review project requirements and make necessary adjustments in fabrication strategy to meet requirements without additional cost or time to Contract.

K. Conduct pre-installation meeting to comply with Section 01 31 00 “Project Management and Coordination.” Review project requirements and make adjustments in installation strategies to meet requirements without additional cost or time to Contract.

1.4 Delivery, Storage, and Handling

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.5 Project Conditions

A. Do not deliver to site or install roller shades until construction, wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Where verification of field dimension is not possible due to progress of the Work, coordinate with necessary trades to determine dimensions and proceed with Shop Drawings.

C. Coordinate with other trades to assure adequate blocking and backing occur for attachment of roller shades, prior to concealment of framing.

D. Coordinate with progress of work, prior to concealment of framing, to assure that necessary conduit and boxes occur within framing for installation and connection of power and controls for roller shades.

1.6 Warranty

A. Provide non-depreciating 25 year warranty for roller shade hardware, chain and shade cloth.

1.7 Extra Materials

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Before installation begins, for each size, color, texture, and pattern indicated, full-size units equal to 5 percent of amount installed.

PART 2 - Products

2.1 Roller Shades

A. Subject to requirements, provide products by one of, or equal to, the following:

1. MechoShade Systems, Inc.

B. Shade Material: PVC-coated fiberglass.

1. Fabric Width: [36 inches] [48 inches] [60 inches] [72 inches] [84 inches] [96 inches] [As indicated on Drawings].
2. Pattern: <Insert pattern.>
4. Colors: As selected by Architect from manufacturer’s full range.
6. Material Openness Factor: <Insert number> percent.
7. Material UV Blockage: <Insert number> percent.
10. Fringe: <Insert fringe style and color>.

C. Provide extruded-aluminum tube rollers of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade material without sagging; designed to be easily removable from support brackets; with [hook-and-loop strip] [removable spline fitting integral channel in tube] for attaching shade material. Provide capacity for one roller shade band per roller.

D. Provide [regular, from back of roller] [reverse, from front of roller] direction of roll.

E. Provide galvanized or zinc-plated steel mounting brackets.

F. Provide L-shaped, extruded aluminum fascia; long edges returned, continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; removable design for access. At conditions where ends are exposed provide fascia end caps, fabricated from steel finished to match fascia or headbox.

G. Provide L-shaped top/back cover; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

H. Provide U-shaped, extruded aluminum pocket-style headbox; long edges returned; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

I. Provide six-sided pocket box units with ceiling slot openings for recessed installation; fabricated from formed-steel sheet, extruded aluminum, or wood; with a bottom consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing rollers, brackets, and operating hardware and operators within; capacity for one roller shade per pocket.
1. Provide factory formed and welded corner section.

J. Provide steel bottom bar, with metal capped ends. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bars as required for smooth, properly balanced shade operation.

K. Provide audiovisual light-blocking shades designed for eliminating all visible light gaps when shades are fully closed; fabricated from blackout shade band material with [fascia] [headbox] [pocket] and bottom bar extended and formed for light-tight joints among shade components and between shade components and adjacent construction.

1. Provide side channels, sill channel and perimeter seals, including sill light seal attached to bottom bar, for eliminating light gaps when shades are closed.
2. Provide side band retention system for guiding shade band material through range of travel and holding shade band flat and taut with edges of material within side channels.

L. Provide system for operable skylight shades, including operator, operating hardware, and accessories for smooth operation, designed for installation in [horizontal position] [inclined position].

1. Provide side channels and bottom channel for concealing rollers, operator take-up operating hardware, and accessories.
2. Provide shade band retention system for guiding shade band material through range of travel and holding shade band flat and taut with edges of material within side channels and firmly attached to cables or wires; including concealed battens or rods connected to fabric guides or exposed idler rollers for stiffening shade band material across glazed opening.

M. Provide mounting as indicated on Drawings. Mounting to allow easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

N. Provide manual shade operation [spring roller] [continuous-loop bead-chain, clutch, and cord tensioner and bracket] lift operator.

1. Position of clutch Operator: As indicated on Drawings.
2. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
3. Provide lift-assist mechanism for balancing roller shade weight and lifting heavy roller shades.
4. Loop Length: [Full length of roller shade] [Length required to make operation convenient from floor level].
6. Provide operating function to stop and hold shade at any position in ascending or descending travel.

O. Provide motorized operator.

2.2 Shade Fabric

A. Shade cloth to be constructed of a woven screen material consisting of yarns comprised of extruded vinyl coated polyester core yarn as a composite thermoplastic shade cloth that shall be sealed at the edges, assuring binding of the core yarn to the coating at the cut edge to ensure a sealed edge to substantially minimize raveling. Screen cloths to have inert yarns; i.e. fiberglass yarns are not acceptable.

2.3 Accessories

A. Provide roller shade pocket for recessed mounting in acoustical tile or drywall ceilings as indicated on Drawings.
1. Provide extruded aluminum pocket.
2. Provide formed steel pocket.
3. Provide removable closure panel for access to shades.

B. Provide wall-mount brackets and fascia end caps for surface-mounted shades.
   1. Provide continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   2. Fascia shall be able to be installed across two or more shade band in one piece.
   3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
   4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
   5. Notching of fascia for manual chain is not acceptable.

C. Guide cable assemblies required at tall lobby shades.

2.4 Roller Shade Fabrication

A. Fabricate roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Provide concealed components fabricated from noncorrodible materials.
   1. Provide lifting mechanism with permanently lubricated moving parts.

C. Obtain units fabricated in sizes to fill window and other openings as follows:
   1. Install shade units between inside jambs with edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
   2. Install shade units outside jambs; width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

D. Design installation brackets for easy removal and reinstallation of shade, for supporting [fascia], [headbox], roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Provide no fewer than two installation fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. For metal components exposed to view, apply color-coated baked finish complying with manufacturer’s written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness. Colors of metal and plastic components exposed to view as selected by Architect from manufacturer’s full range.

G. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.

H. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
I. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.

J. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.

K. Provide shade hardware constructed of minimum 1/8-inch-thick plated steel or heavier as required to support 150 percent of the full weight of each shade.

2.5 Motorized Roller Shade Operators

A. Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.

B. Comply with NFPA 70.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.

D. Provide UL-approved or -recognized, totally enclosed, insulated electric motors, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.

   1. Service Factor: According to NEMA MG 1, unless otherwise indicated.

E. Position of Motor and Electrical Connection: [Left] [Right] side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated [on Drawings] [in a window treatment schedule].

F. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed mounting. Provide the following devices for remote-control activation of shades:

   1. Control Stations: Maintained-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions.


   2. Group Control Stations: Maintained-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for single-switch group control.


G. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.

H. Operating Function: Stop and hold shade at any position.
I. Operating Features: Include the following:

1. Group switching with integrated switch control; single face plate for multiple switch cut-outs.

PART 3 - Execution

3.1 Examination

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of conditions by contractor.

3.2 Roller Shade Installation

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Connect motorized operators to building electrical system.

C. Connect and install all roller shade control systems for complete and functional operation.

3.3 Adjusting

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 Cleaning and Protection

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades. Refer to Section 01 79 00 “Demonstration and Training.”

End of Section 12 24 13
SECTION 12 35 50 - Institutional Casework

PART 1 - General

1.1 Related Documents

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

B. Related Sections:

1. Section 09 22 16 “Non-Structural Metal Framing.”
2. Section 09 65 00 “Resilient Flooring.”

1.2 Definitions

A. MDF: Medium-density fiberboard.

B. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 40 inches above floor, and surfaces visible in open cabinets.

C. Semiexposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 60 inches or more above floor are defined as semiexposed.

D. Concealed Portions of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

E. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive, and faced both front and back with hardwood veneers.

1.3 Submittals

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show fabrication details, including types and locations of hardware. Show installation details, including layout of countertops and locations of field joints and filler panels. Indicate manufacturer's catalog numbers for casework.

C. Samples: 12-by-12-inch samples for each type, color and finish for cabinet doors and boxes. 12-by-12-inch samples of each type, color and finish for countertops. Provide sufficient number of samples to show complete range of variation in wood grain, texture and color.

1. 12-inch-wide section of countertop showing top, front edge, and backsplash construction. Include sub-base material.
2. One full-size finished base cabinet complete with all hardware, doors, and drawers, but without countertop.
3. One full-size finished wall cabinet complete with all hardware, doors, and adjustable shelves.
4. Maintain full-size samples 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 exact locations. If approved samples become damaged during Work, submit new samples for approval.

D. Qualification Data: For qualified installer.

E. Warranty: Sample of special warranty.

1.4 Quality Assurance

A. Provide a qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Provide an installer who is a manufacturer's authorized representative and who is trained and approved for installation of units required for this Project.

C. Obtain manufactured wood casework from single source from single manufacturer.

D. Fabricate cabinets with wood products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

E. Unless otherwise indicated, comply with WI's "Manual of Millwork" for Premium grade. Provide WI-certified compliance certificate indicating that manufactured wood casework complies with requirements of grades specified. Drawings indicate manufactured wood casework configurations by referencing WI design series numbering system as defined in WI’s “Manual of Millwork.”

F. Operable parts for all accessible casework shall comply with CBC Section 11B-309.

1.5 Delivery, Storage, and Handling

A. Deliver manufactured wood casework only after spaces are enclosed and weather tight, wet work is complete, painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. Store casework only in areas where environmental conditions meet requirements specified in "Project Conditions" Article.

B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.6 Project Conditions

A. Do not install manufactured wood casework 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 ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Do not deliver or install manufactured wood casework until building is enclosed, and HVAC system is operating and maintaining temperature between 60° and 90° F and relative humidity between 25 and 55 percent during the remainder of the construction period.

C. Verify actual dimensions of construction contiguous with manufactured wood casework by field measurements before fabrication. Coordinate with necessary trades to determine dimensions.
1.7 Coordination

A. Coordinate with trades to assure locations, layout and installation of framing, blocking, backing, and reinforcements in walls and partitions for support of manufactured wood casework.

1.8 Warranty

A. Manufacturer agrees to repair or replace components of manufactured wood 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.
   d. Deterioration or fading of color and finishes.

2. Warranty Period: Five years from date of Substantial Completion.

1.9 Extra Materials

A. Furnish complete touchup kit for each type, color, and finish of manufactured wood casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

PART 2 - Products

2.1 Manufacturers

A. Subject to requirements, provide products by one of, or equal to, the manufacturers and products listed:

1. Wood-Faced Manufactured Casework:
   a. Architectural Cabinet Systems; a division of Windham Millwork, Inc.
   b. Fisher Hamilton L.L.C.
   d. TMI Systems Design Corporation.

2. Plastic-Laminate-Faced Manufactured Casework:
   a. Architectural Cabinet Systems; a division of Windham Millwork, Inc.
   b. Fisher Hamilton L.L.C.
   c. Hausmann Industries, Inc.
   d. TMI Systems Design Corporation.

2.2 Materials, General

A. Low-Emitting Materials: Provide manufactured wood casework, including countertops, made with adhesives and composite wood products containing no urea formaldehyde.

B. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

C. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core unless otherwise indicated.
D. Hardboard: AHA A135.4, Class 1 Tempered.

E. Cold-Rolled Steel Sheet: ASTM A 1008, suitable for exposed applications.

F. Stainless-Steel Sheet: ASTM A 240 or ASTM A 666, Type 304, with No. 4 satin finish.

G. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
   1. Subject to requirements, provide products by one of, or equal to, the following:
      a. Avonite Surfaces; Aristech Acrylics LLC.
      c. Formica Corporation.
      d. Nevamar Company, LLC; Decorative Products Div.
   2. Provide type indicated.
   3. Provide integral sink bowls that comply with ISSFA-2 and ANSI Z124.3, Type 5 or Type 6, without a precoated finish.

2.3 Cabinet Materials

A. Exposed Cabinet Materials:
   2. Plywood: Hardwood plywood with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch thick, and Grade J crossbands. Provide backs of same species as faces.
      a. Face Veneer Cut: Plain sliced.
   3. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed plywood.
   4. Unless otherwise indicated, provide specified edgebanding on all exposed edges.

B. Semiexposed Cabinet Materials:
   1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of same species as exposed wood.

C. Concealed Cabinet Materials:
   1. Plywood: Hardwood plywood. Provide backs of same species as faces.

2.4 Design, Color, and Finish

A. Provide manufactured wood casework of the following design:
   1. Flush overlay.
B. Wood Colors and Finishes: As selected by Architect from casework manufacturer’s full range including custom colors.

C. PVC Edgebanding Color: As selected from casework manufacturer’s full range of colors.

D. Solid-Surfacing Colors: As selected by Architect from manufacturer’s full range of colors.

2.5 Cabinet Fabrication

A. Provide wood cabinet construction as required by referenced quality standard, but not less than the following:

1. Bottoms of Cabinets and Tops of Wall Cabinets: 3/4-inch veneer hardwood plywood.
2. Ends of Cabinets: 3/4-inch hardwood plywood.
4. Base Cabinet Top Frames: 3/4-by-2-inch solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
5. Base Cabinet Stretcher: 3/4-by-4-1/2-inch hardwood plywood, at front and back of cabinet, glued and screwed.
9. Drawer Sides and Backs: 1/2-inch solid-wood, with glued dovetail joints.
10. Drawer Bottoms: 1/4-inch veneer-core hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch material for drawers more than 24 inches wide.
11. Drawer Bodies: Steel drawer pans formed from 0.0359-inch-thick metal, metallic phosphate treated, and finished with manufacturer's standard 2-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.
12. Doors 48 Inches or Less in Height: 3/4 inch thick, with solid hardwood stiles and rails, MDF cores, and hardwood face veneers and crossbands.
13. Doors More Than 48 Inches in Height: 1-1/8 inches thick, with particleboard cores and hardwood face veneers and crossbands.

B. Provide 3/4-inch plywood filler strips as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate with same finish as cabinets.

2.6 Finish for Wood-Faced Manufactured Casework

A. Sand lumber and plywood for manufactured wood casework construction before assembling. Sand edges of doors and drawer fronts and molded shapes with profile-edged sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.

B. Finish casework after fabrication.

C. Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces to provide uniform color and to match approved samples.

D. Finishing Closed-Grain Woods: Apply two-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat.
E. Finishing Open-Grain Woods: Apply three-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and two coats of a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat and between topcoats.

F. Back prime wood surfaces that will be concealed after installation with clear wood sealer.

2.7 Casework Hardware and Accessories

A. Unless otherwise indicated, provide Satin finish, commercial-quality, heavy-duty all metallic hardware.

B. Provide frameless concealed hinges (European Type) BHMA A156.9, Type B01602, 170 degrees of opening, self-closing. Provide 2 hinges for doors less than 48 inches high and 3 hinges for doors more than 48 inches high.

C. Provide solid stainless-steel wire pulls, fastened from back with two screws. Provide 2 pulls for drawers more than 24 inches wide.

D. Provide dual, self-aligning, permanent magnet door catch. Provide 2 catches on doors more than 48 inches high.

E. Drawer Slides: BHMA A156.9, Type B05091.
   1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated, steel ball-bearing slides.
   2. Box Drawer Slides: Grade 1HD-100 for drawers not more than 6 inches high and 24 inches wide.
   3. File Drawer Slides: Grade 1HD-200, for drawers more than 6 inches high or 24 inches wide.
   4. Keyboard Slides: Grade 1HD-100, for computer keyboard shelves.
   5. Trash Bin Slides: Grade 1HD-100, for trash bins not more than 20 inches high and 16 inches wide.

F. Provide stainless-steel label holders where indicated, sized to receive standard label cards approximately 1 by 2 inches, attached with screws.

G. Provide drawer and hinged door locks where indicated, mortise-type, 5 pin tumbler. Provide in material and finish to match hardware and complying with BHMA A156.11, Grade 1. Provide a minimum of two keys per lock and six master keys.

H. Provide sliding-door hardware sets, to suit type and size of sliding-door units. Match hardware metal and finish.

I. Provide mortise-type, powder-coated steel adjustable shelf supports and shelf rests complying with BHMA A156.9, Types B04071 and B04091.

J. Provide 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage through countertops.

K. Paper Slots: 12 inches long by 1-3/4 inches wide by 1 inch deep; black, molded-plastic, paper-slot liner with 1/4-inch lip.

2.8 Countertops

A. Provide smooth, clean exposed tops and edges in uniform plane free of defects. Provide front and end overhang of 1 inch over base cabinets.
B. Solid-Surfacing-Material Tops: 3/4-inch-thick, solid-surfacing material with front edge built up with same material.
   1. Front: 1-1/2-inch laminated bullnose.
   2. Backsplashes: 3/4-inch-thick, solid-surfacing material; slightly eased at edge.

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 manufactured wood casework.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with installation constitutes acceptance of substrate conditions by Contractor.

3.2 Casework Installation

A. Install level, plumb, and true; shim as required, using concealed shims. Where manufactured wood casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

B. Set base cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Fasten cabinets to masonry or framing, wood blocking, or reinforcements in walls and partitions with fasteners spaced 24 inches on center. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with fasteners spaced 16 inches on center. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than two fasteners.

C. Hang wall cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, or framing, blocking, or reinforcements in walls or partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
   1. Fasten through back, near top and bottom, at ends, and not more than 16 inches on center.
   2. Use expansion anchors at masonry.
   3. Use No. 10 wafer-head screws sized for 1-inch penetration into wood framing or blocking at wood-framed partitions.
   4. Use No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish at metal-framed partitions.

D. 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.

E. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 Installation of Tops

A. Where possible make field jointing 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 approved Shop Drawings.
B. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

C. Secure tops to cabinets with Z- or L-type fasteners or equivalent, using two or more fasteners at each front, end, and back.

D. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection.

E. Secure backsplashes and end splashes to tops and wills with adhesive.

F. Seal junctures of tops, splashes, and walls with clear mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.4 Cleaning and Protecting

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.

C. Provide 10 mil minimum plastic sheet covering to protect countertop and cabinet surfaces. Tape to underside of toe kick at a minimum of 48 inches on center. Remove protection at Substantial Completion.

END OF SECTION 12 35 50
SECTION 21 13 00 – Automatic Fire Sprinkler Systems

PART 1 - General

1.1 Summary

A. Provisions of Division 01 apply to this Section

B. Section Includes:

1. Furnish and install an Automatic Fire Sprinkler System as shown in the Contract Documents.

C. Approval Submittal Procedure:


D. Manufacturer’s Data:

1. Submit complete and detailed equipment and material list of items to be furnished and installed under this Section.

E. Regulatory Requirements:

1. Installation of fire sprinkler system shall be per the Approved Drawings having been stamped “Approved” by DSA.
2. Approval by DSA may include minimum code requirements and does not supersede more extensive requirements of the Contract Documents.

F. Closeout Submittals – Contract closeout as specified herein:

1. Record Drawings:
   a. Record drawings of installed Work shall be maintained current on the Project site and available for the Fire Inspector and the IOR to review.
   b. At completion of installation, submit to the Architect of Record, drawings signed by the installing Contractor and Record Drawings in AutoCAD Format.

2. Record Specifications.
3. Record Product Data: Include specific model, type, and size for all equipment and material installed.
4. Record Samples.
5. Maintenance Manuals.

1.2 References

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the Work of this Section and are hereby incorporated into and made a part of the Contract Documents.


1.3 Quality Assurance

A. Comply with all applicable national, state and local codes and standards.

B. Except where exceeded by the requirements of these specifications, the following are made part of this Section: Approved prints and details and all provisions of the NFPA 13 Standard for Installation of Sprinkler Systems.

C. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a five year history of successful production that is acceptable to the Architect.

D. Qualifications of Installer: Installer shall have a current C-16 license in the state of California for the installation of fire sprinkler systems.

1.4 Coordination

A. The automatic fire sprinkler contractor shall coordinate the installation of the automatic fire sprinkler system with all other trades prior to the installation of the system.

1.5 Job Conditions

A. Unscheduled utility flow interruptions are not permitted. Schedule all service interruptions in advance with the OAR.

1.6 Extra Materials for Maintenance

A. Provide spare sprinkler heads in a quantity equal to two percent (2%) of total number of each type of sprinkler head installed. There shall be no less than two (2) heads of each type and temperature rating provided and in no case less than six (6) spare sprinkler heads per building. There shall be no fewer than six (6) spare sprinkler heads for up to 300 sprinkler heads installed; no less than 12 spare sprinkler heads for up to 1,000 sprinkler heads installed; and no less than 24 sprinkler heads shall be kept inside of spare head box(es). A spare sprinkler wrench for each type of sprinkler head shall also be provided inside of each spare sprinkler head box at each building. Locations of spare sprinkler boxes shall be located at:

1. Fire Sprinkler Riser when enclosed and secure.
2. Plant Manager’s Office when Fire Sprinkler Riser is exposed.

PART 2 - Products

2.1 Fire Protection System Description

A. General: Provide complete systems including, but not limited to:

1. Provide complete overhead Automatic Fire Sprinkler System with sprinklers installed as required according to type, location, and temperature rating indicated on the Contract Documents.

B. Sprinkler Heads:

1. Provide concealed pendant type sprinkler heads in areas with finished ceilings.
2. Provide upright sprinklers with brass finish in areas with exposed piping.
3. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.

4. Sprinklers in concealed spaces, exterior locations and any other areas which will experience over 100 degrees F ambient temperature shall be furnished with 200 to 225 degree rated sprinklers. Sprinkler heads in boiler rooms, furnace rooms, or heater rooms shall be furnished with sprinklers rated at 250 to 290 degrees F. If a sprinkler is directly affected by a spotlight, steam, or other heat source, a 350 degree F or higher sprinkler head shall be furnished. Sprinkler heads in all other locations unless otherwise noted, shall be 155 to 165 degrees F rated.

5. Automatic Fire Sprinkler head types shall be as follows:
   a. In areas with ceiling heights of 9'-0" or lower, sprinkler heads installed shall be recessed or fully concealed.
   b. Ceilings 8'-0" or lower shall be provided with fully concealed sprinkler heads.
   c. Areas with ceiling height of 9'-0" or lower that are not constantly supervised such as corridors, arcades, and restrooms shall be provided with fully concealed sprinkler heads.

6. Sprinkler heads in light hazard occupancies are required to be Quick Response sprinklers as required in NFPA 13. Sprinkler heads shall be of the same manufacturer throughout the building/site as indicated. Sprinklers shall typically be ½ inches NPT, standard orifice, minimum 5.6 nominal K factor, UL listed for 175 psi and listed for light and ordinary hazard occupancies.

7. Sprinkler head location shall be designed and installed in an aesthetically pleasing manner and should generally be located in the center of 24”x24” ceiling tiles and in the center of 24”x48” ceiling tiles in the 24” direction and 12” from the edge in the 48” direction.

8. UL/FM listed Sprinkler head guards shall be provided on Sprinkler heads installed at 7'-6" above floor or lower in exposed locations or are deemed subject to damage. Sprinkler head guards shall be securely fastened with a bolt-on feature to the base of the sprinkler or be a factor installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at 7'-6" heights or lower.


C. Fire Sprinkler Systems:

1. Test-and-drain combination valves are prohibited).

2. Flow indicator shall activate the fire alarm system between 45 and 90 seconds and activate a local alarm on the outside of the building continuously with water flow. All shut-off including valves on the fire main backflow preventer shall be electrically supervised according to CBC 903.4 and NFPA 13.

3. Pipe through ceilings at sprinkler locations shall be furnished with a two-piece or fully concealed escutcheon. Unless otherwise designated, escutcheons shall be identical and match the other escutcheons of the same type throughout the building or site. Piping through walls and ceilings shall have a split ring chrome escutcheon.
   a. A flexible stainless steel sprinkler head drop system may be used. Flexible drops shall be UL listed, FM approved and shall be compatible with ceiling systems. Flexible drop lengths shall be included in the Hydraulic Calculations. The drop system shall include the required support bracing.

4. Furnish and install all required signs, spare heads, special wrenches, and spare sprinkler head boxes as required to satisfy NFPA 13 and this Specification.

5. Sprinkler system piping shall be provided with complete drainage as required by NFPA 13. Inspector’s test valve discharge shall be piped away from planters to asphalt areas or to a hub drain connected to a sanitary or storm drain system. Furnish protection of piping against accidental or malicious damage.
Upon completion of the Work of this Section and before Substantial Completion, subject system to tests is required. A minimum hydrostatic test shall be two hundred pounds (200 psi) or fifty pounds (50 psi) in excess of the maximum system working pressure, whichever is greater for two hours with no leaks or loss of pressure per NFPA 13. The IOR shall be furnished with a NFPA 13 test certification.

Local fire sprinkler alarm requirements shall be accomplished with a vane or paddle type water flow detector switch and an electrically powered fire sprinkler horn located on the street side of the building and connected to the fire alarm control panel with secondary power provided from the fire alarm batteries. The drilled out disk shall be attached to the mounting U-bolt. Time delay shall be set at 45 to 60 seconds. Mechanically activated water bells with alarm valves and pressure switches are prohibited.

Seismic separation assemblies shall be located between the buildings if space allows accessibility. Otherwise, they shall be located inside the building providing the most space. Swing joints may be fabricated on site using flexible groove couplings and six (6) grooved 90 degree elbows (see NFPA 13, Figure A.9.3.3 (a)). Seismic separation assemblies can also be made utilizing a manufactured, UL/FM listed seismic joint assembly rated at a minimum of 175 psi.

Hanging, bracing, and support shall utilize only UL/FM listed approved products and comply with NFPA 13, Chapter 9 requirements for rod and bolt sizes.

2.2 Materials

A. Access Panel:

   FAP-1 Square, steel, prime-coated with vandal-proof door lock operated by an Allen wrench

B. Globe or Angle Valves: UL/FM Listed:

   AV-1 Bronze angle valve: Two inches and smaller, screwed-in bonnet, threaded ends, rising stem

C. Automatic Fire Sprinkler Head, UL/FM listed:

   AFSH-1 Brass pendant type for areas without ceilings
   AFSH-2 Brass upright type for areas without ceilings
   AFSH-3 Chrome or poly-coated, semi-recessed type with semi-recessed escutcheon
   AFSH-4 Fully concealed type sprinklers; chrome or factory painted cover

D. Gear Operated Butterfly Valves:

   GOBFV – 1 Grooved end Gear Operated Butterfly Valve, 300 psi, for fire protection sprinkler risers. UL listed, FM approved, with weatherproof gearbox and double pole/double throw monitor switch, double seal design for bubble tight shut off at 175 psi. Corrosion-resistant, fusion-bonded Nylon II body coating, easy to read position indicator.
   GOBFV-2 Wafer Type Gear Operated, Butterfly Valve same requirements as GOBFV-1.

E. Check Valves:

   CV-1 Bronze check valves: Two (2) inches and smaller, 200 psi WOG, bronze disc, swing type, conforming to MSS-SP-80-97, threaded ends.
   CV-2 Iron check valves: 2-1/2” and larger, Class 175, composition disc, swing type, bolted cap, UL listed, FM approved flanged ends
CV-3  Wafer Type Check Valve
CV-4  Grooved Check valve 2-1/2” and larger

F. Sprinkler Escutcheons
   SE-1  Concealed sprinklers shall have a low profile (flat) cover plate that is listed for use with the sprinkler to which it is installed. Cover plates shall be factory painted or plated with a finish or color approved by the Architect.
   SE-2  Recessed sprinkler shall have low profile two piece escutcheons that are listed for use with the sprinkler to which it is installed. Escutcheons shall be factory painted or plated with a finish and color approved by the Architect.

G. Flow Indicators
   FIA-1  Listed by State Fire Marshal with a double pole, double-throw switch, one normally closed, UL listed and FM approved.

H. Outside Stem and Yoke Gate Valves
   OS&Y-1  Bronze Gate Valves: Two (2) inches and smaller, Class 175, solid bronze wedge disc, OS&Y copper silicon alloy stem, UL/FM listed, threaded ends
   OS&Y-2  Iron gate valves: 2-1/2” and larger, Class 175, IBBM, OS&Y, solid wedge disc, Teflon-impregnated packing UL/FM listed, flanged ends

I. Gear Operated Ball Valves:
   GOBV -1  Threaded ball valve for sizes two (2) inches and smaller.

J. Seismic Swing Joints:
   SJ-1  UL/FM approved flexible seismic connector with grooved or threaded ends for seismic separation requirements.
   SJ-2  Fabricate swing joints as per NFPA 13 using six groove 90 degree elbows and flexible groove couplings.

K. Sprinkler Guards:
   SPG-1  Sprinklers installed at 7’-6” above floor or lower in exposed locations or that are deemed subject to damage shall be equipped with a UL/FM listed, head guard. Guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer. Sprinkler head guards shall be securely fastened with a bolt-on feature to the base of the sprinkler or be a factory installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at 7’-6” heights or lower.

L. Hangers, Supports, Bracing:
   HSB-1  Tolco products or UL listed or FM approved equal

M. Threaded Fittings:
   TF-1  Ductile iron, 300 psi rated, UL listed, FM approved and/or NFPA approved.
   TF-2  Cast iron fittings, 175 psi rated, UL listed, FM approved and/or NFPA approved.
   TF-3  Malleable Iron, 300 psi rated, UL listed, FM approved and/or NFPA approved.
Automatic Fire Sprinkler Systems

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N. Fire Sprinkler Pipes:

**FSP-1**
Fire Sprinkler Pipe: 1” through 8” Schedule 40 black and/or galvanized steel, meeting ASTM Standards A53, A135 and/or A795. Pipe Corrosion Resistance Ratio (CRR) shall be 1.00 or greater. Pipe may be threaded or grooved.

a. Piping two (2) inches and smaller shall have threaded joints and fittings in all concealed, non-accessible locations. Groove coupler connections (Victaulic or equal) on pipe sizes one (1) inch through two (2) inches are acceptable in all accessible areas. Plain end connections such as “Plainlock” and “FIT” are prohibited.

b. For pipe size 2-1/2 inches and larger, grooved type welded, threaded and flanged connections may be used. Any connection that does not utilize a threaded, welded or grooved connection is prohibited.

c. Submit verification from the manufacturer stating that piping material furnished meets above criteria; (i.e., threadable pipe has a UL assigned CRR of 1.00 minimum that it meets ASTM A53, A135, or A795 and is UL listed, FM approved and/or NFPA approved.

**FSP-2**
Flexible Fire Sprinkler Head Connectors: One (1) inch pipe size, flexible stainless steel fire sprinkler head connectors, “Flex Head Industries”, Models 2024, 2036, 2048, 2060, and 2072 or equal.

### 2.3 Accessories and Appurtenances

A. Escutcheons: Polished chrome plated, split-ring type for exposed piping at every penetration inside finished rooms.

B. Guards: Provide fire sprinklers with guards as required in 7’-6” ceilings and where required by the Architect.

C. Miscellaneous: Provide all other accessories and appurtenances required for a complete system.

### PART 3 - Execution

#### 3.1 Examination

A. Examine areas and conditions under which the Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.2 Preparation

A. Ream pipe and tube ends. Remove all burrs. Thread bevel for welding or groove all plain end ferrous pipe ends.

B. Remove scale and foreign matter from inside and outside of the pipes before assembly.

C. Provide piping connections to equipment with flanged or grooved connections.

#### 3.3 Installation

A. Pipe through floors, wall, and ceilings at head locations, shall be furnished with required sleeves and escutcheons and fire caulking where indicated and/or required by Code. Escutcheons shall be polished chrome plated unless another finish is selected by the Architect.
B. Sprinkler system shall be provided with complete drainage facilities in accordance with CBC standards. Drain discharge may discharge into a sewer, storm drain, sump pit or street gutter. Fire sprinkler drains shall not discharge onto landscaping or across a sidewalk. Discharge may be to a hub drain designed to receive a full flow of water from a fire sprinkler drain valve under working pressure.

C. Upon completion of the Work of this Section and before substantial completion, subject the entire system to tests as required by NFPA 13 and CBC standards and furnish the Owner with a Certificate of Compliance as required.

D. Close nipples are prohibited. Threaded unions are prohibited. A groove type fitting shall be used in lieu of a threaded union. If a groove style coupling is used in a concealed area, an access panel allowing full access to that connection shall be provided.

E. Fire sprinkler systems, piping hangers, seismic bracing, anchors and supports shall conform to all NFPA 13, CBC and all other applicable codes and the requirements of this Specification.

F. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer.

G. Tee branch outlets on fire sprinkler mains shall be by the use of a threaded ductile iron tee fitting, a groove type tee fitting, or by the use of a thread-a-let welded on by a certified welder as required by NFPA 13. Mechanical tee bolted branch outlet fittings are prohibited except for branch outlet sizes two (2) inches and smaller. “Hooker” type mechanical tees shall not be used.

H. Sprinkler lines within the building shall be concealed within the structure. Risers shall be installed in utility, supply rooms, or similar service areas whenever possible and shall not obstruct access or maintenance of other equipment within the space. Mains and risers shall be located within the area protected by the sprinkler system unless otherwise approved by fire authorities having jurisdiction.

I. Sprinklers that have been dropped, damaged, have cracked bulbs, or show a visible loss of fluid shall not be installed.

J. Sprinkler bulb protectors shall be removed by hand after sprinkler installation. Tools or any other device to remove the protector that could damage the bulb in any way shall not be used.

K. Routing of piping in non-concealed exposed areas shall be subject to the Architect’s approval.

L. Underground piping shall have a minimum bury depth as specified in NFPA 24. Underground pipe shall be installed on a flat undisturbed sand bed. After the required pressure-leak, pipe shall be covered with sand not less than 6 inches thick before backfilling. Comply with all NFPA 24 standards.

M. Provide approved backflow prevention assemblies as required. Installations of backflow prevention assemblies shall be tested and certified by a certified backflow prevention device tester prior to substantial completion. Tests shall be performed in the presence of the IOR. Test reports shall be turned over to the IOR for mailing to the proper agency.

N. Provide shunt trip when sprinklers are installed in the elevator machine rooms and elevator hoist way unless the sprinklers are located two (2) feet or less from the hoist way pit floor.

O. The discharge from Inspectors test valves (ITV) and main drain lines shall be piped to a hub drain, sump pit or to the outside of the building to within a foot from the ground where it will drain away from the building to an exterior storm drain.
3.4 Protection

A. Protect the Work of this Section until substantial completion.

3.5 Clean-Up

A. Remove rubbish, debris, and waste materials and legally dispose at off-project site.

End of Section 21 13 00
Section 22 05 23 - General Duty Valves

PART 1 - General

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

1.2 Summary
A. Section Includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 Definitions
A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 Submittals
A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
B. Product Data: For each type of valve indicated.
1.5 **Quality Assurance**

A. **Source Limitations for Valves:** Obtain each type of valve from single source from single manufacturer.

B. **ASME Compliance:**
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. **NSF Compliance:** NSF 61 for valve materials for potable-water service.

1.6 **Delivery, Storage, And Handling**

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

**PART 2 - Products**

2.1 **General Requirements For Valves**

A. Refer to valve schedule articles for applications of valves.

B. **Valve Pressure and Temperature Ratings:** Not less than indicated and as required for system pressures and temperatures.

C. **Valve Sizes:** Same as upstream piping unless otherwise indicated.

D. **Valve Actuator Types:**
   1. **Handwheel:** For valves other than quarter-turn types.
   2. **Handlever:** For quarter-turn valves NPS 6 and smaller.
   3. **Chainwheel:** Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. **Valves in Insulated Piping:** With 2-inch stem extensions and the following features:
   1. **Gate Valves:** With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 Bronze Ball Valves

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. Kitz Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
2.3 Bronze Swing Check Valves

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hammond Valve.
   b. Kitz Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:

   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hammond Valve.
   b. Kitz Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:

   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

2.4 Bronze Gate Valves

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hammond Valve.
   b. Kitz Corporation.
General Duty Valves

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

B. Class 125, RS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Kitz Corporation.
      c. Milwaukee Valve Company.
      d. NIBCO INC.

   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 200 psig.
      d. Ends: Threaded.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron.

2.5 Examination

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

2.6 Valve Installation

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance,
and equipment removal without system shutdown.

**B.** Locate valves for easy access and provide separate support where necessary.

**C.** Install valves in horizontal piping with stem at or above center of pipe.

**D.** Install valves in position to allow full stem movement.

**E.** Install check valves for proper direction of flow and as follows:

1. **Swing Check Valves:** In horizontal position with hinge pin level.
2. **Center-Guided and Plate-Type Check Valves:** In horizontal or vertical position, between flanges.
3. **Lift Check Valves:** With stem upright and plumb.

### 2.7 Adjusting

**A.** Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 2.8 General Requirements For Valve Applications

**A.** If valve applications are not indicated, use the following:

1. **Shutoff Service:** Lead free Ball, gate or plug valves.
   
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
   c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

**B.** If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

**C.** Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

### 2.9 Domestic Cold Water Valve Schedule

**A.** Pipe NPS 2 and Smaller: (shall be lead free)

2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

**B.** Pipe NPS 2-1/2 and Larger: (shall be lead free)

1. Iron Valves, NPS 2-1/2 to NPS 4: Provided with flanged ends.
2. Iron Ball Valves: Class 150.
PART 3 - Execution

3.1 Valve Installation

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for gate and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 Adjusting

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 General Requirements For Valve Applications

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
   c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.4 Domestic Cold Water Valve Schedule
A. Pipe NPS 2 and Smaller:
   2. Bronze Angle Valves: Class 125, bronze disc.
   3. Ball Valves: Two piece, full port, bronze with bronze trim.
   4. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: Flanged ends.
   2. Iron Swing Check Valves: Class 125, metal seats.
   3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
   4. Iron Gate Valves: Class 125, NRS.

End Of Section 22 05 23
Section 22 05 29 - Hangers and Supports

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

1.3 Definitions

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 Performance Requirements

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.
5. Pipe positioning systems.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Fiberglass strut systems. Include Product Data for components.
4. Pipe stands. Include Product Data for components.
5. Equipment supports.

D. Welding certificates.

1.6 Quality Assurance

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

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 Manufacturers

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 Steel Pipe Hangers And Supports

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

2. ERICO/Michigan Hanger Co.
3. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 Trapeze Pipe Hangers

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 Metal Framing Systems

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. Tolco Inc.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 Fastener Systems

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturer shall be Hilti only.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturer shall be Hilti only.

2.6 Pipe Stand Fabrication

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Portable Pipe Hangers.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

   a. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 Pipe Positioning Systems

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.8 Equipment Supports

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 Miscellaneous Materials

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
PART 3 - EXECUTION

3.1 Hanger And Support Applications

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
8. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
9. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
10. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
14. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
15. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
13. Light (MSS Type 31): 750 lb.
a. Medium (MSS Type 32): 1500 lb.
b. Heavy (MSS Type 33): 3000 lb.

14. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
15. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
16. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.
3.2 Hanger And Support Installation

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

O. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

Q. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 Equipment Supports

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 Metal Fabrications

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 Adjusting

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 Painting

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

End of Section 22 05 29
Section 22 07 00 - Plumbing Insulation

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Insulation Materials: Mineral fiber
2. Adhesives.
3. Field-applied jackets.

1.3 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For product indicated. Include thermal conductivity, thickness, and jackets.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail application of field-applied jackets.

1.4 Quality Assurance

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 Delivery, Storage, And Handling

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 Coordination
A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1.7 Scheduling

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - Products

2.1 Insulation Materials

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide the following:
   a. Johns Manville; Micro-Lok.
   b. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 Adhesives

A. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:
   a. Childers Products, Division of ITW; CP-82.

2.3 Field-Applied Jackets

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.

   a. Factory cut and rolled to size.
   b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   c. Factory-Fabricated Fitting Covers:
1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 General Installation Requirements

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
4. For below ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 General Pipe Insulation Installation

A. Insulation Installation on Fittings, Valves, Flanges, and Unions:

1. Install insulation over fittings, valves, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.  
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

B. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.5 Mineral-Fiber Insulation Installation

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.  
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.  
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.  
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.  
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.  
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.  
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.  
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.  
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.  
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.  
4. Install insulation to flanges as specified for flange insulation application.

3.6 Field-Applied Jacket Installation
A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 Outdoor, Field-Applied Jacket Schedule

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Exposed:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

End of Section 22 07 00
Section 22 11 16 – Domestic Water Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
4. Flexible connectors.
5. Escutcheons.
6. Sleeves and sleeve seals.
7. Wall penetration systems.
8. Transitions fittings.
9. Dielectric fittings.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 Performance Requirements

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.4 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
7. Sleeves and sleeve seals.
8. Water penetration systems.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Domestic water piping.
2. HVAC hydronic piping.

D. Field quality-control reports.

1.5 Quality Assurance

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 Project Conditions

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

1.7 Coordination

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 Piping Materials

A. All piping, fittings and accessories shall be manufactured exclusively in the United States.

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.

2.2 Copper Tube And Fittings

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper. Only allowed for trap primers.

### 2.3 Piping Joining Materials

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use 15% silver brazing filler metal without flux.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

### 2.4 Encasement For Piping

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Tube.

C. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.

### 2.5 Specialty Valves

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

### 2.6 Transition Fittings

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.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.7 Dielectric Fittings

A. General Requirements:

1. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric connections shall be cast brass union/coupling with 6 inch brass nipples.

2.8 Flexible Connectors

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

1. Flex-Hose Co., Inc.
2. Hyspan Precision Products, Inc.
3. Metraflex, Inc.
4. Proco Products, Inc.
5. Universal Metal Hose; a Hyspan company

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.9 Escutcheons

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.


D. One Piece, Stamped Steel: Chrome-plated finish with setscrew.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.
2.10 Sleeves

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.11 Sleeve Seals

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Calpico, Inc.
   2. Metraflex, Inc.
   3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Pressure Plates: Stainless steel.
   2. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.12 Wall Penetration Systems

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   3. Housing-to-Sleeve Gasket: NBR.
   4. Housing-to-Carrier-Pipe Gasket: AWWA C111, NBR.

2.13 Grout

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 Piping Installation

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. 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.

C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

D. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

E. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

F. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

G. Install shutoff valve immediately upstream of each dielectric fitting.

H. Install domestic water piping level and plumb.

I. Rough-in domestic water piping for water-meter installation according to North Orange County Community College District requirements.

J. 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.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.
3.2 Joint Construction

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 Valve Installation

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

3.4 Transition Fitting Installation

A. Install transition couplings at joints of dissimilar piping.
B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. NPS 2 and Larger: Sleeve-type coupling.

3.5 Dielectric Fitting Installation

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   1. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric connections shall be cast brass union/coupling with 6 inch brass nipples.
3.6 Flexible Connector Installation

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.7 Hanger And Support Installation

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. NPS 6: 10 feet with 5/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.
3.8 Connections

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
   2. 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 Escutcheon Installation

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:
   1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
   5. Bare Piping in Equipment Rooms: One piece, cast brass.
   6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 Sleeve Installation

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
   a. Extend sleeves 2 inches above finished floor level.
   b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
3. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
4. Sleeves for Piping Passing through Exterior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6.
   b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
   c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
   d. Do not use sleeves when wall penetration systems are used.

3.11 Sleeve Seal Installation

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.12 Wall Penetration System Installation

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.13 Identification

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.
3.14 Field Quality Control

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by North Orange County Community College District Representatives.
   2. During installation, notify North Orange County Community College District Representatives at least one day before inspection must be made. Perform tests specified below in presence of North Orange County Community College District Representatives:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for North Orange County Community College District Representatives to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If North Orange County Community College District Representatives find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by North Orange County Community College District Representatives.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 Adjusting

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
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.

3.16 Cleaning

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by North Orange County Community College District Representatives; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to North Orange County Community College District Representatives. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 Piping Schedule

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Trap primer piping:

1. Soft copper tube, ASTM B 88, Type K with no joints.

D. Under-building-slab, domestic water, building-service piping, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard or compact-pattern mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, shall be the following:
1. Hard copper tube, ASTM B 88, Type L with wrought-copper solder-joint fittings; and 15% silver solder brazed joints.

3.18 Valve Schedule

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

2. Throttling Duty: Use ball or globe valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

End of Section 22 11 16
Section 22 11 19 - Domestic Water Piping Specialties

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Strainers.
   3. Drain valves.
   4. Trap-seal primer systems.

1.3 Performance Requirements

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
PART 2 - Products

2.1 Vacuum Breakers

A. Hose-Connection Vacuum Breakers:

1. Manufacturer shall be Acorn.
5. Finish: Chrome or nickel plated.

2.2 Strainers For Domestic Water Piping

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.

2.3 Trap-Seal Primer Systems

A. Trap-Seal Primer Systems (Pressure Drop Activated):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB Inc.
   b. ZURN, Inc.
2. Type: Pressure drop activated.
3. Standard: ASSE 1044,
4. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
5. Cabinet: Recessed-mounting steel box with stainless-steel cover.
7. Number Outlets: Four.
9. Pressure Drop: 3 psi or less.

B. Trap-Seal Primer Systems (Electronic):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB Inc.
   b. ZURN, Inc.
2. Type: Electronic.
3. Standard: ASSE 1044,
4. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
5. Cabinet: Recessed-mounting steel box with stainless-steel cover if installed within wall.
7. Number Outlets: Four.
9. Electrical: 120 VAC or 24 VDC, manual override switch, 5 amp breaker, 24 hr timer relay and adjustable delay.

2.4 Water Hammer Arresters

A. Water Hammer Arresters:
   1. Manufacturers: Provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
   3. Type: Metal bellows.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - Execution

3.1 Installation

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install balancing valves in locations where they can easily be adjusted.

C. Provide temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Provide thermometers and water regulators.
   2. Provide cabinet-type units recessed in or surface mounted on wall.

D. Provide Y-pattern strainers for water on supply side of each control valve and pump.

E. Provide trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

F. Provide water hammer arrestors to lavatories, sinks, fountains, water closets, urinal headers and other fixtures or devices with quick closing valves, such as clothes washers. Locate water hammer arrestor in wall complete with access panel.

3.2 Connections

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
3.3 **Labeling And Identifying**

A. **Equipment Nameplates and Signs:** Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Outlet boxes.
4. Hose stations.
5. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 **Field Quality Control**

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

C. Perform water hammer arrestor testing per PDI requirements.

3.5 **Adjusting**

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

End of Section 22 11 19
Section 22 13 16 - Sanitary Waste and Vent Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following for soil, waste, and vent piping manufactured exclusively in the United States, inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground metal piping.

1.3 Performance Requirements

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:


1.4 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For pipe, tube, fittings, and couplings.

C. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

D. Field quality-control inspection and test reports.

1.5 Quality Assurance

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
PART 2 - Products

2.1 Manufacturers

A. Manufacturers:
   1. AB&I
   2. Tyler
   3. Charlotte

2.2 Piping Materials

A. All piping, fittings and accessories shall be manufactured exclusively in the United States.

B. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 Hubless Cast-Iron Soil Pipe And Fittings

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.


      a. Manufacturers:

         1) ANACO / Husky SD 4000.
         2) Tyler Pipe; Soil Pipe Div.

2.4 Encasement For Underground Metal Piping

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.

B. Form: tube.

PART 3 - Execution

3.1 Piping Applications

A. Aboveground, soil, waste and vent piping, all pipe sizes shall be any of the following:

   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

B. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel or heavy-duty shielded, cast-iron couplings; and hubless-coupling joints.
C. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Extra-Heavy class, cast-iron soil piping; calking materials; and calked joints.
   2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel and heavy-duty shielded, cast-iron couplings; and hubless-coupling joints.

3.2 Piping Installation

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.


   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

M. Provide clean-outs above all urinals, lavatories, upper terminal water closets and sinks.

1. For water closets, a cleanout shall be provided at the end of run for two or more water closets. Cleanout shall be located 4-6” above the flood level of the water closets.
2. For urinals, a cleanout shall be provided either above the flush valve for each urinal or at the end run of two or more urinals (located 4-6” above flood level of urinals)
3. For lavatories, a cleanout shall be provided at the end run above counter or at counter height if there is interference with a mirror.

N. Avoid locating cleanouts in ceiling/attic/plenum spaces. If possible, locate cleanouts in a wall with access panel above the ceiling/attic/plenum spaces.

O. Provide cleanouts to grade in yard box at:

1. Upper terminal cleanout within 5 feet of building line connection
2. Every 50 feet or change in direction over 135 degrees
3. At property line connection

P. Sewage pit shall be lined with high-density polyethylene (HDPE).

Q. Sewage Ejections System control panel shall have equipment markings (tags).

R. Access to sewage ejection pumps and control panel shall be 3’ clear.

S. Provide sway brackets at the POC (Point of Connection) of pressurized piping (sewer, sump) to gravity fed piping.

3.3 Joint Construction

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.4 Valve Installation

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Install backwater valves in accessible locations.
3. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 Hanger And Support Installation

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.

G. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 10 feet with 3/8-inch rod.
   2. NPS 3: 10 feet with 1/2-inch rod.
   3. NPS 4 and NPS 5: 10 feet with 5/8-inch rod.
   4. NPS 6: 10 feet with 3/4-inch rod.

H. Install supports for vertical cast-iron soil piping every 15 feet.

3.6 Connections

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

3.7 Field Quality Control
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

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. 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. 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.

3.8 Cleaning

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.

End of Section 22 13 16
Section 22 13 19 - Sanitary Waste Piping Specialties

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Through-penetration firestop assemblies.
5. Flashing materials.

1.3 Definitions

A. Retain acronyms and abbreviations that remain after this Section has been edited.
C. FOG: Fats, oils, and greases.
D. FRP: Fiberglass-reinforced plastic.
E. HDPE: High-density polyethylene plastic.
F. PE: Polyethylene plastic.
G. PP: Polypropylene plastic.
H. PVC: Polyvinyl chloride plastic.

1.4 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated in Part 2

C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.
1.5 Quality Assurance

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


1.6 Coordination

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - Products

2.1 Cleanouts

A. Exposed Metal Cleanouts:

1. Manufacturers: Provide products by one of the following:
   b. Zurn Plumbing Products Group; Light Commercial Operation.
   c. Josam Company.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Manufacturers: Provide products by one of the following:
   b. Zurn Plumbing Products Group; Light Commercial Operation.
   c. Josam Company.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Outlet Connection: Spigot
8. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Size: Same as connected branch.
15. Housing: Stainless steel.
17. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Provide products by one of the following:
   b. Zurn Plumbing Products Group; Light Commercial Operation.
   c. Josam Company.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Option for drilled-and-threaded plug in first subparagraph below is for a screw for a wall cover plate.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 Floor Drains

A. Cast-Iron Floor Drains:

1. Manufacturers: Provide products by one of the following:
   b. Zurn Plumbing Products Group; Light Commercial Operation.
   c. Josam Company.
2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: 6”
12. Top Loading Classification: Heavy Duty
13. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2.3 Through-Penetration Firestop Assemblies
A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Fitting in subparagraph below is for use with plastic stacks.
7. Coating in subparagraph below is for use with corrosion-resistant plastic stacks.
8. Special Coating: Corrosion resistant on interior of fittings.

2.4 Miscellaneous Sanitary Drainage Piping Specialties

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.
2.5 Flashing Materials

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - Execution

3.1 Installation

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.
5. Service sink cleanouts shall be installed at least flood level of fixture, preferably 4-6” above flood level of fixture.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Air-admittance valves in first two paragraphs below cannot replace all vent piping. They should be used only where normal venting is difficult. If used, they should be indicated on Drawings.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

J. Assemble open drain fittings and install with top of hub 1 inch above floor.

K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

O. Install vent caps on each vent pipe passing through roof.

P. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

Q. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

R. Install wood-blocking reinforcement for wall-mounting-type specialties.

S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 Connections

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 Flashing Installation

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

End of Section 22 13 19
Section 22 40 00 - Plumbing Fixtures

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section specifies service sinks.

1.3 Related Sections:

A. Division 01 Section "Sustainable Design Requirements" for LEED submittal requirements.

1.4 Definitions

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.


1.5 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. LEED Submittals:

1. Prerequisite WEp1 and Credit WEc3. Refer to Division 01 Section "Sustainable Design Requirements" for additional submittal requirements.
1.6 Quality Assurance

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Regulatory Requirements: Comply with requirements in "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.


D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.

1.7 Warranty

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures of unit shell.
   b. Faulty operation of controls, etc.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

PART 2 - Products

2.1 Lavatory Faucets

A. Lavatory Faucets: For L-1
1. Manufacturers: CHICAGO MODEL 650-4CP or approved equal:

2. Description: Hard wire – 4” Lavatory, Sensor activated, 128-NF Transformer with 6 volt DC powered electronic faucet. Include hot- and cold-water supply connection with flexible high-pressure hose and strainer; coordinate faucet inlets with supplies and fixture holes. Provide Sloan 135A mixing valve with integral check valves.
   b. Finish: Polished chrome plate.
   c. Centers: 4 inches.
   d. Mounting: Deck, exposed.
   e. Inlet(s): NPS 3/8 tubing, with NPS 1/2 male adaptor.
   f. Spout: Integral.
   g. Spout Outlet: 0.35 GPM aerator spray head.
   h. Operation: Sensor, 0.2 gallons/cycle
   i. Tempering Device: Integral.

2.2 Waste Fittings: L-1 & 2

   A. Standard: ASME A112.18.2/CSA B125.2.
   B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
   C. Trap:
      2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
      3. Provide with integral insulation as manufactured by McGuire.

2.3 Flushometers

   A. Flushometers: For water closets
      2. Description: Flushometer for water closet. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, brass tubing, and polished chrome-plated finish on exposed parts.
         a. Internal Design: Diaphragm operation.
         b. Style: Exposed.
         c. Inlet Size: NPS 1.
         d. Trip Mechanism: Battery powered, electronic-sensor actuator.
         e. Consumption: 1.28 gal./flush.
         f. Tailpiece Size: NPS 1-1/2.

   B. Flushometers: For ADA water closets
      1. Manufacturers: Sloan Optima Smooth valve Model 111-1.28 ES-S.
2. Description: Flushometer for water closet. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   c. Inlet Size: NPS 1.
   d. Trip Mechanism: Battery powered, electronic-sensor actuator.
   e. Consumption: 1.28 gal./flush.
   f. Tailpiece Size: NPS 1-1/2.

C. Flushometers: For Urinals

1. Manufacturers: Sloan 1000.1301-0.125-ES-S
2. Description: Flushometer for urinals. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   d. Trip Mechanism: Battery powered, electronic-sensor actuator.
   e. Consumption: 0.125 gal./flush.

2.4 Toilet Seats

A. Toilet Seats:

1. Manufacturers: Olsonite 95SSCT or equal product by one of the following:
   a. Centoco Manufacturing Corp.
   b. Church Seats.
2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic with antimicrobial agent.
   b. Configuration: Open front without cover.
   c. Size: Elongated.
   d. Hinge Type: SC, self-sustaining, check.
   e. Class: Heavy-duty commercial.

2.5 Protective Shielding Guards

A. Protective Shielding Pipe Covers: For all lavatories and sinks

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. McGuire Manufacturing Co., Inc.
   b. Or approved equal.
2. Description: Manufactured integral plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.6 Fixture Supports

A. Manufacturers: Provide products by one of the following:

2. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Josam

B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: Type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

2.7 Water Closets

A. Water Closets: WC-1 & 2

1. Manufacturers: American Standard 3351.128 or equal.
2. Description: Wall-mounted, back-outlet, vitreous-china fixture designed for flushometer valve operation.

a. Style: One piece.

   1) Bowl Type: Elongated with siphon-jet design.
   2) Design Consumption: 1.28 gal./flush.
   3) Trip Mechanism: Lever-handle actuator.
   4) Color: White.


c. Style: Flushometer valve.

   1) Design Consumption: 1.28 gal/flush.

d. Flushometer: See Flushometer in this Section.

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e. Toilet Seat: See Toilet Seat in this Section.
f. Fixture Support: See Fixture Support in this section.

B. Water Closets, WC-2: Same as WC-1 except mounted at accessible height.

2.8 Lavatories

A. Lavatories, L-1:

2. Fixture:
   b. Type: For under counter mounting.
   c. Nominal Size: Oval, 15”x12”.
   d. Faucet-Hole Punching: Three holes.
   e. Faucet-Hole Location: Top.
   g. Mounting Material: Sealant and fixture support mounting kit.

2.9 Sinks

A. Sinks, KS-1:

1. Manufacturers: Just USF-ADA-1933-A-GR or equal products by one of the following manufacturers.
   a. Elkay
2. Description: Double-compartment with integral countertop, stainless-steel commercial sink. Verify exact dimensions with architectural drawings.
   a. Overall Dimensions: 19” x 33” x 5-1/2”
   b. Metal Thickness: 18 gauge.
   c. Compartment:
      1) Dimensions: 19” x 33”x 5-1/2”
      2) Drain: McGuire 152 drain and McGuire PWV8912NCO.
         a) Location: Rear back of compartment.
   d. Faucet(s): Chicago 200ACP-317 FAUCET.
      1) Number Required: One.
      2) Mounting: deck.
      3) Design Consumption: 1.5 GPM.
   e. Supplies: Chicago 1006ABCP loose key stops with rigid supplies.
   f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; tubular brass waste to wall; continuous waste; and wall escutcheon(s); with integral insulation.

2.10 Sinks

A. Sinks, S-1:
1. Manufacturers: Just SL-ADA-1921-A-GR or equal products by one of the following manufacturers.
   a. Elkay

   a. Overall Dimensions: 19” x 33” x 5-1/2”
   b. Metal Thickness: 18 gauge.
   c. Compartment:
      1) Dimensions: 19” x 33” x 5-1/2”
      2) Drain: McGuire 152 drain and McGuire PWV8912NCO.
         a) Location: Rear back of compartment.
   d. Faucet(s): Chicago 200ACP-317 FAUCET.
      1) Number Required: One.
      2) Mounting: deck.
      3) Design Consumption: 1.5 GPM.
   e. Supplies: Chicago 1006ABCP loose key stops with rigid supplies.
   f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; tubular brass waste to wall; continuous waste; and wall escutcheon(s); with integral insulation.

PART 3 - Execution

3.1 Examination
   A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
   B. Examine walls and surrounding space for suitable conditions where fixtures will be installed.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation
   A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
   B. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
   C. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
   D. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
   E. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
F. Install traps on fixture outlets.

G. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

H. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

3.3 Connections

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 Field Quality Control

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 Adjusting

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust controls. Replace damaged and malfunctioning units and controls.

3.6 Cleaning

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.
3.7 Protection

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the North Orange County College Distric Representative.

End of Section 22 40 00
SECTION 22 47 00 – Electric Water Coolers

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section includes pressure water coolers and related components.

1.3 Action submittals

A. Product Data: For each type of pressure water cooler.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 Closeout submittals

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - Products

2.1 Electric Water Coolers, EWC-1

A. Pressure Water Coolers: Wall mounted, standard, wheelchair accessible.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.
      b. Oais.
      c. Haws Corporation.
   2. Cabinet: Bi-level with two attached cabinets.
   3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
   5. Drain: Grid with NPS 1-1/4 tailpiece.
   8. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
   9. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
Electric Water Coolers

PART 3 - Execution

3.1 Examination

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 Installation

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Provide mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.

D. Provide water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use lead free ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Provide trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Provide wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
3.3 Connections

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Provide lead-free ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 Adjusting

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 Cleaning

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 00
SECTION 23 00 00 – General Mechanical Requirements

PART 1 - General

1.1 Related Documents

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

1.2 Scope

A. Basic mechanical requirements specifically applicable to Division 23 Sections.

B. Work includes but is not necessarily limited to the following:

1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:

   a. Heating, ventilating and air conditioning systems and equipment
   b. Testing, adjusting and balancing

1.3 Drawings and Specifications

A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers’ recommendations, and in a first class manner.

B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.

C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after NOCCCD has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by NOCCCD’s Representative.

D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.

E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.4 Utilities

A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.
B. Mechanical Contractor shall be fully responsible to survey all underground utilities prior to installation of any utilities.

1.5 Applicable Reference Standards, Codes and Regulations

A. Meet requirements of all state codes having jurisdiction.

B. State of California Code of Regulations:
   1. Title 8, Industrial Relations
   2. 2013 California Building Code (CBC), Title 24, Part 2
   3. 2013 California Electrical Code, Title 24, Part 3
   4. 2013 California Mechanical Code, Title 24, Part 4
   5. 2013 California Plumbing Code, Title 24, Part 5
   6. 2013 California Fire Code, Title 24, Part 9
   7. 2013 California Standards Code, Title 24, Part 12
   8. 2013 Title 24, Energy Conservation Standards
   9. 2013 California Green Building Standards Code, Title 24, Part 11

C. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to NOCCCD’s Representative.

D. Obtain permits, and request inspections from authority having jurisdiction.

1.6 Project and Site Conditions

A. The arrangement of and connection to equipment shown on the drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.

C. Examine site related work and surfaces before starting work of any Section.

D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

E. Prepare revised shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the NOCCCD’s Representative before proceeding.

F. Beginning work of any Section constitutes acceptance of conditions.

1.7 Cooperation with Work Under Other Divisions

A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.

C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

D. Make such progress in the Work to not delay work of other trades.

1.8 Discrepancies

A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify NOCCCD’s Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.

B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.

C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to NOCCCD’s Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without NOCCCD’s Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.9 Changes

A. The Contractor shall be responsible to make and obtain approval from the NOCCCD’s Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions.

B. All changes shall be clearly indicated on the "Record" drawings.

1.10 Submittals

A. For each Division 23 submittal section, provide the following:

1. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

   a. “No Exception Taken”.
   b. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package.

1. Individual or partial submittals are not acceptable and will be returned without review.

C. Note that prior to acceptance of shop drawings for review, a submittal schedule shall be submitted to the NOCCCD’s Representative.

D. Shop Drawings:
1. Provide all shop drawings in latest version of AutoCAD format.
2. Drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of 1/4-inch per foot, except as specified otherwise.
3. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
4. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
5. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.

E. Whenever more than one (1) manufacturer’s product is specified, the first named product is the basis of design used in the Work and the use of alternate-named manufacturer’s products or substitutes may require modifications in that design.

F. Proposed Products List: Include Products as required by the individual section in this Division.

G. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the NOCCCD’s Representative bearing the NOCCCD’s Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the NOCCCD’s Representative without additional compensation.

H. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.

I. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the NOCCCD Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the NOCCCD Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

J. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.

K. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.11 **Product Alternatives or Substitutions**

A. Refer to Division 01 for additional requirements.
1.12 Guarantee

A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to NOCCCD.

B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to NOCCCD for their service agency as directed.

1.13 Operation and Maintenance Manual

A. Refer to Division 01 for additional requirements.

1.14 Posted Operating Instructions

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

B. The operating instructions shall include control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.15 Instruction to the NOCCCD Personnel

A. Refer to Division 01 for additional requirements.

B. Provide training as specified in individual sections.

C. Before final inspection, instruct NOCCCD’s designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times. Furnish the services of competent instructors to give full instruction to NOCCCD personnel in the adjustment, operation, and maintenance of systems and equipment, including pertinent safety requirements. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

D. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with NOCCCD’s personnel in detail to explain all aspects of operation and maintenance.

F. Contractor shall video tape all in service training and instruction sessions and provide DVD, properly indexed, for training additional and future maintenance personnel.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

H. Submit six copies of Manufacturer’s Instruction Certificates as specified in individual specification Sections.
1.16 Manufacturer’s Recommendations

A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.17 Project Record Documents

A. Refer to Division 01 for additional requirements.

B. Maintain on site, one set of the following record documents; record actual revisions to the Work:

2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed shop drawings, product data, and samples.

C. Store Record Documents separate from documents used for construction. Record documents shall be available for review by the Construction Inspector and Engineer at all times.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and Modifications.

F. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Field changes of dimension and detail.
2. Details not on original Contract Drawings.
3. Provide all record documents and shop drawings in electronic format.

G. All changes, deviations and information recorded on the “Project Record Drawings” set during Construction shall be redrafted onto the latest version of AutoCAD.

1. Contractor hand marked or drafted redlined “Project Record Drawings” will not be accepted.

H. Submit completed shop drawings to NOCCCD prior to completion in AutoCAD format.

1.18 Delivery and Storage

A. Refer to Division 01 for additional requirements.

B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction.” Replace damaged or defective items with new items.

1.19 Extra Materials
A. Refer to Division 01 for additional requirements.

B. Unless otherwise specified, spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words “spare parts.” A neatly type inventory of spare parts shall be taped to the underside of the cover.

1.20 Commissioning

A. Division 23 will be responsible to carry out the commissioning requirements specified in Section 230800 and other sections referenced in Section 230800.

B. Management:

1. The Commissioning Agent (CA) is hired directly by NOCCCD.
2. The CA directs and coordinates the commissioning activities and the reports to NOCCCD’s Representative.
3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and NOCCCD Representative.
5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

C. Commissioning requires the participation of Division 23 Mechanical Contractor to work to ensure that all systems are operating in a manner consistent with the Design Intent.

1. The general commissioning requirements and coordination are detailed in Division 1 and Section 230800.
2. This Division shall be familiar with all parts of Division 1 and Division 23 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

D. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and NOCCCD Representative has signed off on the commissioned systems.

1.21 Commissioning Responsibilities

A. Mechanical Contractor: The commissioning responsibilities applicable to the mechanical contractor are as follows (all references apply to commissioned equipment only):

1. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and NOCCCD Representative.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
3. General Contractor shall attend a commissioning kickoff meeting and other meetings necessary to facilitate the commissioning process.
4. General Contractor shall provide the Commissioning Provider with normal cut sheets and shop drawing submittals of commissioned equipment.
5. General Contractor shall provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Provider for development of start-up and functional testing procedures.
   a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Provider.
   b. The Commissioning Provider may request further documentation necessary for the commissioning process.
6. General Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Provider for review.
7. Sub-Contractors and design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
8. General Contractor shall provide limited assistance to the Commissioning Provider in preparing the specific functional performance test procedures. Sub-Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
9. General Contractor shall develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and the pre-functional checklists from the Commissioning Provider for all commissioned equipment. Submit to Commissioning Provider for review prior to startup.
10. During the startup and initial checkout process, execute the mechanical related portions of the pre-functional checklists for all commissioned equipment.
11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Provider.
12. Address current Engineer of Record punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
14. Provide skilled technicians to perform functional performance testing under the direction of the Commissioning Provider. Assist the Commissioning Provider in interpreting the monitoring data, as necessary.
15. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Provider, NOCCCD’s Representative and Engineer of Record and retest the equipment.
16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
17. During construction, maintain as-built redline drawings for all drawings and final AutoCAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning.
18. Provide training of NOCCCD Representative’s operating staff using expert qualified personnel, as specified.
19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
20. Execute any deferred functional performance testing, witnessed by the Commissioning Provider, according to the specifications.

21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.
2. Assist and cooperate with the TAB contractor and Commissioning Provider by:
   a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
   b. Including cost of sheaves and belts that may be required by TAB.
   c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug.
   d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor, which is an input point to the control system.
4. List and clearly identify on the as-built drawings the locations of all air-flow stations.
5. Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the Commissioning Provider. Update the schedule as appropriate.
6. Notify NOCCCD’s Representative when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify NOCCCD’s Representative or Commissioning Provider, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

PART 2 - Products (Not applicable)

PART 3 - Execution

3.1 General

A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to NOCCCD’s Representative.

3.2 Work Responsibilities

A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.

B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.

E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify NOCCCD immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from NOCCCD.

G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of NOCCCD and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.

H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

I. Replace or repair, without additional compensation, any work, which, in the opinion of NOCCCD, does not comply with these requirements.

3.3 **Painting**

A. Refer to Division 09 for additional requirements.

B. Factory Applied:

1. Mechanical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
2. Refer to individual sections of this Division for more stringent requirements.

C. Field Applied:

1. Paint all mechanical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
2. Paint all exposed, uninsulated mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
3. Paint ductwork flat black that are visible behind air outlets and inlets.
4. Paint all exposed and rooftop ductwork, roof mounted mechanical equipment, ductwork supports, hangers and appurtenances.
5. Paint shall be a high performance polyurethane enamel coating system.
   a. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal.
   b. Acceptable primer manufacturers include Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
   c. Provide minimum 5 mils dry film thickness.

3.4 **Commissioning Training of NOCCCD'S Representative Personnel**

A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of NOCCCD’s Representative personnel for commissioned equipment.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the Commissioning Provider and A/E with a training plan at least two weeks before the planned training.
2. Provide designated NOCCCD personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
   a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
   c. Discussion of relevant health and safety issues and concerns.
   d. Discussion of warranties and guarantees.
   e. Common troubleshooting problems and solutions.
   f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
   g. Discussion of any peculiarities of equipment installation or operation.
   h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless approved otherwise by NOCCCD’s Representative.

End of Section 23 00 00
SECTION 23 05 17 – Sleeves and Sleeve Seals for HVAC Piping

PART 1 - General

1.1  Related Documents

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

1.2  Summary

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.3  ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a
written statement that the submitted equipment, hardware or accessory complies with the requirement of
that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and
other requirements along with proposed alternative.

B. Product Data:

1. Provide product data for each item listed.
2. Provide data indicating service temperature requirements.

PART 2 - Products

2.1  Sleeves

A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar;
zinc coated.

B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with
plain ends.

C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded
longitudinal joint.

D. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure
pipe, with plain ends and integral waterstop unless otherwise indicated.
2.2 Sleeve-Seal Systems

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

1. LinkSeal
2. Advance Products & Systems, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 Sleeve-Seal Fittings

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

1. Presealed Systems.
2. Holdrite

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.4 Grout


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - Execution

3.1 General

A. Provide products based on service temperature requirements.

1. Chilled Water: 40-70°F.
2. Heating Hot Water: 150-180°F.
3. Condenser Water: 80-100°F.

3.2 Sleeve Installation

A. Install sleeves for piping passing through wall penetrations.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-
inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 Sleeve-Seal-System Installation

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 Sleeve-Seal-Fitting Installation

A. Provide:
   1. Sleeve-seal fittings in new walls and slabs as they are constructed.
   2. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
   3. Secure nailing flanges to concrete forms.
   4. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 Sleeve and Sleeve-Seal Schedule

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping NPS 8 inch and smaller: Galvanized-steel wall sleeves, galvanized-steel-pipe sleeves or sleeve-seal fittings.
2. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

4. Interior Partitions:

End of Section 23 05 17
SECTION 23 05 18 – Escutcheons for HVAC Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.3 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated.

PART 2 - Products

2.1 Escutcheons

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 Floor Plates

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - Execution

3.1 Installation
A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with concealed hinge.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 Field Quality Control

A. Replace broken and damaged escutcheons and floor plates using new materials.

End of Section 23 05 18
SECTION 23 05 19 – Meters and Gages for HVAC Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Thermometers.
2. Thermowells.
3. Pressure gages - dial-type.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.

1.3 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data:

1. For each type of product indicated.
2. For each gage, provide data indicating that the:
   a. High limit of range does not exceed a factor of 1.5x the standard operating point for that particular system.
   b. System operating pressure is found within the middle 1/3 of overall range.

C. Wiring Diagrams: For power, signal, and control wiring.

1.4 Informational Submittals

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - Products
2.1 General

A. Select gages such that the high limit of range does not exceed a factor of 1.5x the standard operating point for that particular system.

B. Select pressure gages so that system operating pressure is found within the middle 1/3 of overall range.

C. Select thermometers so that system operating temperatures is found within the middle 1/3 of overall range.

2.2 Bimetallic-Actuated Thermometers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. WIKA Instrument Corporation - USA.


3. Case: Silicone liquid-filled and sealed; stainless steel Type 304 with 5-inch nominal diameter.

4. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

5. Connector Type): Union joint, adjustable angle or everyangle, with unified-inch screw threads.


7. Lagging Extension: Include on thermometers for insulated piping and tubing.

8. Stem:
   a. Diameter shall be 0.25 inch.
   b. Stainless steel, Type 304.
   c. Length based on pipe requirements.


11. Element: Bimetal coil.


13. Accuracy: Plus or minus 1 percent of scale range.

2.3 Thermowells

A. Thermowells:


2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: CUNI.

4. Material for Use with Steel Piping: Type 316 stainless steel.

5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.

8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 Pressure Gages

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. WIKA Instrument Corporation - USA.

3. Case: Glycerin liquid filled, hermetically sealed, solid-front, pressure relief type; stainless steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 Test Plugs

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

1. Peterson Equipment Co., Inc.
2. Trerice, H.O. Co.
3. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 275 °F.

F. Core Inserts: Nordel (Ethylene-Propylene self sealing rubber).

2.6 Test-Plug Kits

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

1. Peterson Equipment Co., Inc.
2. Trerice, H.O. Co.
3. Weiss Instruments, Inc.
B. Furnish one test-plug kit containing two thermometers, one pressure gage and adapter and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1-2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 °F.

D. Pressure Gage: Small, bourdon-tube insertion type with 2 to 3 inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

E. Carrying Case: Metal or plastic, with formed instrument padding.

### 2.7 Gage Attachments

A. Snubbers: ASME B40.100, brass; with NPS 1/4 ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads at all gauges.

C. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

### 2.8 Thermal-Energy Meters

A. Refer to Specification Section 230900 “Instrumentation and Controls for HVAC” for Thermal Energy Meters requirements.

### PART 3 - Execution

#### 3.1 Installation

A. Thermowells:

1. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

B. Pressure Gages:

1. Select pressure gages so that system operating pressure is found within the middle 1/3 of overall range.
2. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
3. Install gage valve and pressure snubber in piping for each pressure gage for fluids.
4. Provide loop-shaped section of brass pipe with NPS 1/4 pipe threads at all gauges.

C. Thermometers:

1. Select thermometers so that system operating temperatures is found within the middle 1/3 of overall range.
2. Install thermometers in piping tees with thermometer located on pipe at the most readable position.
3. Install gage valve and coil siphon in piping for each thermometer.

D. Install flow indicators in piping systems in accessible positions for easy viewing.

E. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

F. Install permanent indicators on walls or brackets in accessible and readable positions.

G. Install connection fittings in accessible locations for attachment to portable indicators.

H. Install thermometers in the following locations:
   1. Inlet and outlet of building.
   2. Inlet and outlet of each hydronic zone.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Two inlets and two outlets of each hydronic heat exchanger.
   5. Inlet and outlet of chiller evaporator and condenser water pipe.
   6. Inlet and outlet of cooling tower.
   7. Suction and discharge of each pump.
   8. Inlet and outlet of high efficiency filter.
   9. Refer to Mechanical Drawing Piping and Instrumentation Diagrams for additional information for required locations.

I. Install pressure gages in the following locations:
   1. Inlet and outlet of building.
   2. Suction and discharge of each pump.
   3. Two inlets and two outlets of each hydronic heat exchanger.
   4. Inlet and outlet of chiller evaporator and condenser water pipe.
   5. Inlet and outlet of cooling tower.
   6. Inlet and outlet of high efficiency filter.
   7. Provide loop-shaped section of brass pipe with NPS 1/4 pipe threads at all gauges.
   8. Refer to Mechanical Drawing Piping and Instrumentation Diagrams for additional information for required locations.

J. Install test plugs in:
   1. Piping tees.
   2. Inlet and outlet of all air handling unit coil connection points including all subbranched serving stacked coils.
   3. Adjacent to all thermometers and pressure gages.
   4. Adjacent to all temperature and pressure control sensor locations.
   5. Refer to Mechanical Drawing Piping and Instrumentation Diagrams for additional information for required locations.

3.2 Connections

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines and equipment.

3.3 Adjusting
A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 Thermometer Schedule

A. Thermometers at inlet and outlet of building shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic zone shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

E. Thermometers at inlet and outlet of each chiller evaporator and condenser water pipe shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each cooling tower shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

G. Thermometers at suction and discharge of each pump shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

H. Thermometers at inlet and outlet of high efficiency filter shall be the following:
   1. Liquid-filled, sealed, bimetallic actuated type.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.5 Thermometer Scale-Range Schedule

A. Thermometers must read in middle 1/3 during normal operating temperature.

B. Scale Range for Chilled Water Piping: 0 to 100 °F or as indicated on Chilled Water Piping and Instrumentation Diagrams.
C. Scale Range for Heating Hot Water Piping: 30 to 212 °F or as indicated on Heating Hot Water Piping and Instrumentation Diagrams.

D. Scale Range for Condenser Water Piping: 0 to 130 deg F or as indicated on the Condenser Water Piping and Instrumentation Diagrams.

E. Scale Range for Process Cooling Water Piping: 0 to 100 °F or as indicated on the Process Cooling Water Piping and Instrumentation Diagrams.

3.6 Pressure-Gage Schedule

A. Pressure gages must read in middle 1/3 during normal operating pressure.

B. Pressure gages at inlet and outlet of building shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each pump shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

D. Pressure gages at inlet and outlet of heat exchanger shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

E. Pressure gages at inlet and outlet of each chiller evaporator and condenser water pipe shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

F. Pressure gages at inlet and outlet of each cooling tower shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

G. Pressure gages at inlet and outlet of high efficiency filter shall be the following:
   1. Liquid-filled, sealed, solid-front, pressure-relief, direct mounted, metal case.
   2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.7 Pressure-Gage Scale-Range Schedule

A. Scale Range for Chilled Water Piping: 0 to 100 psi or as indicated on Chilled Water Piping and Instrumentation Diagrams.

B. Scale Range for Heating Hot Water Piping: 0 to 50 psi or as indicated on Heating Hot Water Piping and Instrumentation Diagrams.
C. Scale Range for Condenser Water Piping: 30 in. Hg to 50 psi or as indicated on Condenser Water Piping and Instrumentation Diagrams.

D. Scale Range for Process Cooling Water Piping: 0 to 100 psi or as indicated on Process Cooling Water Piping and Instrumentation Diagrams.

End of Section 23 05 19
SECTION 23 05 23 - General Duty Valves for HVAC Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
   1. Bronze ball valves.

B. Related Sections:
   1. Section 230553 "Identification for HVAC" for valve tags and schedules.

1.3 Definitions

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
B. Product Data:
   1. For each type of valve indicated.
   2. Provide AWWA C504 compliance affidavit for below grade butterfly valves.

1.5 Quality Assurance
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      2. ASME B31.1 for power piping valves.
      3. ASME B31.9 for building services piping valves.
      4. AWWA C504-87 for rubber seated butterfly valves.

1.6 Delivery, Storage, and Handling
   A. Prepare valves for shipping as follows:
      1. Protect internal parts against rust and corrosion.
      2. Protect threads, flange faces and weld ends.
      3. Set gate valves closed to prevent rattling.
      4. Set ball and plug valves open to minimize exposure of functional surfaces.
      5. Set butterfly valves closed or slightly open.
      6. Block check valves in either closed or open position.
   B. Use the following precautions during storage:
      1. Maintain valve end protection.
      2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - Products

2.1 General Requirements for Valves
   A. Refer to HVAC valve schedule articles for applications of valves.
   B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
   C. Valve Sizes: Same as upstream piping unless otherwise indicated.
   D. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1.

2.2 Bronze Ball Valves (Size 2 Inch And Smaller)

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nibco, Inc.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Seats: PTFE or TFE.
      g. Stem: Stainless steel. Provide NIB-Seal or equal plastic extension handle for chilled water and process cooling water valves.
      h. Ball: Stainless steel, vented.
      i. Port: Full.

2.3 Butterfly Valves High-Performance (Size 2-1/2 Inch And Larger)

A. Class 150, Single-Flange, Butterfly Valves High-Performance:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jamesbury; a subsidiary of Metso Automation.
      b. Crane Co.; Crane Valve Group; Stockham Division.
      c. Tyco Valves & Controls; a unit of Tyco Flow Control.
   2. Description:
a. Standard: MSS SP-68.
b. CWP Rating: 285 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, or ductile iron.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

3. Accessories:
   a. Butterfly manufacturer provided chainwheel on operators for valves NPS 4 and larger.

2.4 Bronze Swing Check Valves (Size 2 Inch And Smaller)

A. Class 200, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nibco, Inc.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow or upward flow
      e. Ends: Threaded.
      f. Disc: Bronze.

2.5 Iron, Center-Guided Check Valves (Size 2-1/2 Inch And Larger)

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nibco, Inc.
      b. Muller Steam Specialty; a division of SPX Corporation
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      a. Standard: MSS SP-125
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      d. Style: Compact Wafer
      e. Seat: Bronze
PART 3 - Execution

3.1 Examination

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 Valve Installation

A. Install valve at the following locations even if it is not specifically detailed in the drawings:

1. Shut-off Valves – Chilled Water, Heating Hot Water and Process Cooling Water:
   a. Supply and return at each piece of equipment, such as air handling units, fan coils units, variable air volume (VAV) boxes, pumps, etc.
   b. At each floor level branch from risers

B. Install valves:

1. To be readily accessible by maintenance personnel with appropriate means for exercising and removing these valves. This means that the valves shall be:
   a. Within 8'-0” of the floor or within a 24” radius of an elevated access location. An elevated access location is defined as those points accessible using a ladder but no more than 3’-0” above the top rung of the ladder, where acceptable ladder lengths include a 6’-0” A-frame, 8’-0” A-frame and extension ladders up to 20’ long.
   b. here necessary, extensions are to be provided in high ceilings or congested areas to meet these requirements or piping shall be routed to facilitate this accessibility.

2. With unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
3. In horizontal piping with stem at or above center of pipe.
4. In position to allow full stem movement.

C. Install check valves for proper direction of flow and as follows:

1. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3.3 Adjusting

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing.

B. Replace valves if persistent leaking occurs. Do not attempt to repair defective valves; replace with new valves.

3.4 General Requirements for Valve Applications

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball and butterfly valve depending on size.
2. Throttling Service: Ball or butterfly valve depending on size.
3. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze silent check valve, two-piece body with female threaded NPT ends, stainless steel spring and Teflon seat.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Soldered ends.
2. For Steel Piping, NPS 2-1/2 to NPS 6: Flanged ends.

3.5 Chilled Water Valve Schedule

A. Pipe NPS 2 and Smaller:

2. Ball Valves: Two piece, full port, stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 and larger: Flanged ends.
2. High-Performance Butterfly Valves: Class 150, single flange.
3. Iron Swing Check Valves: Class 125, metal seats.

3.6 Heating Hot Water Valve Schedule

A. Pipe NPS 2 and Smaller:

2. Ball Valves: Two piece, full port, stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 and larger: Flanged ends.
   2. High-Performance Butterfly Valves: Class 150, single flange.
   3. Iron Swing Check Valves: Class 125, metal seats.

3.7 Condenser Water Valve Schedule

A. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 and larger: Flanged ends.
   2. High-Performance Butterfly Valves: Class 150, single flange.
   3. Iron Swing Check Valves: Class 125, metal seats.

3.8 Process Cooling Water Valve Schedule

A. Pipe NPS 2 and Smaller:
   2. Ball Valves: Two piece, full port, stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 and larger: Flanged ends.
   2. High-Performance Butterfly Valves: Class 150, single flange.
   3. Iron Swing Check Valves: Class 125, metal seats.

End of Section 23 05 23
SECTION 23 05 29 - Hangers and Supports for HVAC

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Pipe stands.
   6. Piping supports.
   7. Equipment supports.

B. Related Sections:
   1. Section 23 31 13 "Metal Ducts" for duct hangers and supports.

1.3 Definitions

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 Performance Requirements

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment.
1.5 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated.

C. Delegated-Design Submittal:

1. For all mechanical equipment, hardware and accessories that will be used on this project, provide detailed submittal that is signed and sealed by the qualified professional engineer responsible for their preparation. Structural Engineering drawings do not detail all supports for mechanical equipment, hardware and accessories.
   a. Detail fabrication and assembly of duct and pipe supports.
   b. Design Calculations: Calculate requirements for designing duct and pipe supports.

D. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

   1. Trapeze pipe hangers.
   2. Pipe stands.
   3. Equipment supports.

1.6 Informational Submittals

A. Welding certificates.

1.7 Quality Assurance

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - Products

2.1 Metal Pipe Hangers and Supports

A. Carbon-Steel Pipe Hangers and Supports:

   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

B. **Copper Pipe Hangers**:

1. **Description**: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. **Hanger Rods**: Continuous-thread rod, nuts, and washer made of copper-coated steel.

C. **Above Ground Vertical Riser Clamp**:

1. Manufacturer shall be Pipe Shields Inc. Model E2100.
2. Carbon steel pipe material, steel straps and base that is compliance with ASTM A36.
3. Insulation shall be calcium silicate, asbestos free, treated with water repellant.
4. Jacket shall be galvanized steel that is in compliance with ASTM A-527.
5. Fasteners shall comply with ASTM A-307 plated.
6. Coating shall be primer coated.

2.2 **Trapeze Pipe Hangers**

A. **Description**: MSS SP-69, Type 59, shop or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 **Thermal-Hanger Shield Inserts**

A. **Insulation-Insert Material for Cold Piping**: ASTM C 552, Type II cellular glass with 100-psig.

B. **Insulation-Insert Material for Hot Water Piping**: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig.

C. **For Trapeze or Clamped Systems**: Insert and shield shall cover entire circumference of pipe.

D. **For Clevis or Band Hangers**: Insert and shield shall cover lower 180 degrees of pipe.

E. **Insert Length**: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 **Fastener Systems**

A. **Powder-Actuated Fasteners**: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturer shall be Hilti only.

B. **Mechanical-Expansion Anchors**: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturer shall be Hilti only.
2.5 Pipe Stands

A. General Requirements for Pipe Stands: Shop or field fabricated assemblies made of manufactured corrosion-resistant components to support piping.

B. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

2.6 Equipment Supports

A. Description:

1. Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2. Provide seismic support design based on the selected equipment.
   a. Manufacturer shall be Mason, MW Sausse or approved equal.

2.7 Miscellaneous Materials

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - Execution

3.1 Hanger and Support Installation

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89 for Chilled and Heating Hot water. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Installer should be certified by Powder Actuated Tool Manufacturer.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 Equipment Supports

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

D. Provide seismic support design based on the selected equipment. Manufacturer shall be Mason, MW Sausse or approved equal.

3.3 Metal Fabrications

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 Adjusting

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.5 Painting

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 Hanger and Support Schedule

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
13. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
16. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 6, from single rod if horizontal movement caused by expansion and contraction might occur.

I. Vertical-Piping Riser Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Provide on all chilled water and heating hot water pipes through slab at vertical risers on each floor.
3. Refer to 2.1C Above Grade Riser Clamp specifications above for additional requirements.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Structure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.

12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
14. Installer should be certified by Powder Actuated Tool Manufacturer.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

9. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
10. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
11. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

End of Section 23 05 29
SECTION 23 05 48 - Vibration Isolation and Seismic Restraints

PART 1 - General

1.1 Related Documents

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

1.2 Description

A. Work in this section includes, but is not necessarily limited to, furnishing all labor, materials, and equipment for the installation of vibration isolation mounts, brackets, base frames where required, seismic restraints, flexible connectors, pipe isolation hangers, and ductwork isolation hangers. The installation shall be complete in every respect, tested, and adjusted to be in excellent working order.

1.3 Related Work Specified Elsewhere

A. Isolated HVAC Equipment including (but not limited to) Air Handlers, Fans, Pumps, Piping, Ductwork.
B. Internally-isolated Equipment.
C. Plumbing Equipment including (but not limited to) Compressors, Pumps, Piping.
D. Electrical Equipment including (but not limited to) Transformers, Dimmers, Buses.
E. Concrete for equipment bases (housekeeping pads) and inertia blocks.
F. Flexible electrical connections to motors and vibrating equipment.
G. Flexible duct connections to fans and other vibrating elements.
H. Pipe suspension systems, connectors and couplings.

1.4 General Requirements For The Manufacturer

A. Schedules: Consult vibration isolation schedule(s) in drawings or specifications for equipment types and required isolation devices including types, static deflections, bases, seismic restraints, etc. Static deflections specified are based on the anticipated equipment characteristics. In the event the equipment proposed by the Contractor has characteristics other than those indicated, particularly the rated rpm, the static deflection shall be re-evaluated and the proper mountings and other devices shall be provided.
B. Equipment: Provide vibration isolators, base frames, inertia bases and seismic restraints of sufficient size and distribution to assure that deflection, stability and seismic restraint requirements are met. For typical units, no fewer than four isolators shall be provided. Isolators shall be provided to deflect uniformly under operating gravity and equipment thrust loadings to within ±10% of specified deflection values.
C. Specific Equipment: Specific manufacturer's equipment items are listed in this specification. All current and complete requirements from the listed manufacturer of these items shall be integral to this specification, unless such requirements conflict with requirements herein.
D. Instructions to Contractor:
1. Provide written installation instructions to the Contractor.
2. Provide a visit or visits to the jobsite before equipment is installed for the purposes of instruction. During the visit the manufacturer will inspect intended equipment locations and instruct installers in correct equipment installation procedure and sequence.

E. Final Inspections: Provide a visit or visits to the jobsite after equipment is installed for the purposes of inspection. Identify all improperly installed vibration isolation equipment and instruct the contractor in corrective work.

1.5 General Requirements For The Contractor

A. Short-Circuiting: Rigorously avoid short-circuiting to the building any vibration-isolated piece of equipment, pipe, duct or other component. Short-circuits with or via rigid conduits, drain lines, rigid braces, rigid sleeves, framing, etc. all shall be avoided. The Contractor shall oversee trades to prevent the short-circuiting of any vibration isolation system and shall bring any unresolved conflicts to the Architect's attention.

B. Extra Parts: Supply and install any incidental equipment or parts needed to meet the requirements stated, even if not specified or shown on drawings, without claim for additional payment.

C. Package Units: Where equipment within Package Units is provided with separate isolators by the equipment manufacturer and the package enclosure is scheduled to be on an isolator assembly, the internal isolators shall be removed or permanently blocked and the isolated components they supported shall be rigidly attached to the enclosure.

D. Pre-Installation Instruction by Manufacturer: Make installers of vibration isolation equipment available for instruction by the equipment Manufacturer as required in Paragraph 1.4.D.2.

E. Post-Installation Inspection and Adjustment:

1. After each equipment unit installation is complete and under full operational load, vibration isolators shall be adjusted so that loads are transferred to them and away from temporary blocking washers and shims. Blocks and shims then shall be removed and used as gauges to judge required clearances. Washers shall be moved away.

2. Inspect all vibration-isolated equipment, coordinate the work of all involved trades, and see that vibration isolators are not short-circuited by seismic restraints, drain lines, conduits, stanchions, control tubing, duct connections, pipe connections, etc. Ensure that hanger isolators and their rods or wires do not touch any other building component.

3. Obtain "rough-in" inspection and approval from the Architect of any installation to be covered or enclosed, prior to such closure.

4. Schedule final inspection(s) by the equipment Manufacturer after installation as required in Section 1.4.E. Obtain "rough-in" inspection by the Manufacturer of any installation to be covered or enclosed, prior to such closure.

F. Response to Punchlists: Upon completion of the work, the Architect or Architect's representative will carry out an inspection of the project and of final project record documents and will inform the installing contractor via punchlists of any further work that must be completed. Correct, at no additional cost to the NOCCCD, all installations that are deemed defective in workmanship or materials by the Architect or Architect's representative.

1.6 Material Requirements

A. Design Life: Bases, vibration isolation equipment, and seismic restraint equipment shall be capable of surviving the life of the equipment served.
1. All materials, components and parts shall be new.
2. All metal parts of vibration isolators to be installed out of doors shall be hot-dip galvanized after fabrication. Galvanizing shall comply with ASTM A 123, A 153, and A 386 as applicable.

B. Springs: Springs shall be so selected and installed that the ratio of spring diameter to final compressed height shall be no less than 0.8 and no more than 1.2. Further, each spring shall have a minimum additional travel to solid equal to 50% of its actual deflection.

C. Neoprene Elements: All elastomeric mounts, pads, bushings, sleeves, grommets, washers, etc., shall have a Shore-A hardness of 30 to 50 durometer after minimum aging of 20 days or corresponding oven-aging.

D. Bases: For equipment that is not constructed with a base structure compatible with vibration isolation mounts, a base frame shall be supplied with the isolators. A base frame shall also be supplied where an item or equipment and its drive motor require a common rigid base.

E. Seismic Restraints: Seismic restraints shall resist a seismic acceleration in any direction in accordance with all relevant codes without damage or deformation to equipment, building or mounts. Restraints shall not short-circuit vibration isolators during normal operation. Generally, there shall be as many seismic restraints as there are vibration isolators on a piece of equipment. Restraints and isolators shall be located close together on equipment or frames.

1.7 Speed And Balance Requirements for Rotating Equipment

A. Speed Limits: Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Balancing: Rotating devices such as fans shall be balanced according to the schedule below. The following maximum velocity levels (measured in all directions at the fan bearing(s)) shall not be exceeded when the equipment is floating freely on the scheduled vibration isolators:

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>VELOCITY, in/s (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fans</td>
<td>0.09</td>
</tr>
<tr>
<td>Pumps</td>
<td>0.13</td>
</tr>
</tbody>
</table>

C. Remedial Work: Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question or exceeding the above displacement values.

1.8 Submittals By The Manufacturer

A. Compliance: Comply with the requirements of the General Conditions Section.

B. Specifications: Submit Manufacturer's specifications and other data needed to prove compliance with all specified requirements.

C. Installation Instructions: Submit Manufacturer's recommended installation instructions and procedures.

1. Written instructions and checklists to be delivered to the Contractor to aid in proper installation of manufacturer's equipment.
D. Schedules and Shop Drawings: Submit schedules and large scale Shop Drawings clearly showing all pertinent data including, but not limited to:

1. Schedule: Submit a schedule indicating tag number, location and type of all vibration isolators. This shall be sufficiently clear to suffice as a checklist and index for information outlined below.
2. Design Tabulation: Submit a complete tabulation showing for each vibration isolator:
   a. Design load.
   b. Static deflection expected under the design load.
   c. Specified minimum static deflection.
   d. Additional deflection to solid under design load.
   e. Ratio of spring height to spring diameter under design load.

3. Details: Submit details of seismic restraints, steel brackets, steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, and vibration isolator and seismic restraint mounting attachment methods.
4. Galvinization: Submit certified statement by the galvanizer at the time of shipment indicating that outdoor equipment conforms with all ASTM specifications.

E. Structural Requirements: Submit the following:

1. Seismic Restraint: Submit calculations by a structural engineer licensed in the state in which the building is to be erected, certifying that all seismic restraints, bolts, cables and associated components will conform with all pertinent seismic-related requirements.
2. Thrust Restraint: Submit calculations for required thrust restraint of each fan. Calculations to be based on Mason Industries Data Sheet DS-207.

F. Exceptions: Identify all proposed changes, differences and/or discrepancies, including verbiage, terms and definitions between Contract Documents and submittals.

G. Samples: Submit samples of any or all proposed equipment at no charge to the NOCCCD.

H. Detrimental Field Conditions: Submit a list of all field conditions which the manufacturer has determined will limit the specified operational performance requirements specified for isolation devices.

1.9 Submittals By The Contractor

A. Compliance: Comply with the requirements of the General Conditions Section.

B. Contract Closeout: At completion of installation, submit the following documents. Submission of these documents must be complete before final acceptance of vibration isolation systems is given. Assistance from the vibration isolation equipment Manufacturer may be required.

1. A complete tabulation showing for each vibration isolator: (a) the actual static deflection measured at the project and (b) the specified minimum static deflection.
2. A report certifying a) that each piece of operative rotating mechanical equipment does not exceed the specified vibration displacement level and b) that each piece of isolated equipment or equipment component (ducts, pipes, conduit, etc.) is not short-circuited by any means and c) that the requirements of section 2.00 are satisfied for all equipment.
1.10 Quality Assurance

A. Manufacturer's Responsibility: A single firm shall be responsible for the design, fabrication and delivery of vibration isolation equipment, including all components and seismic restraints.

B. Manufacturer's Experience: The Manufacturer shall have successful experience in vibration isolation and seismic control equipment fabrication, including no less than five years experience in fabrication and delivery of equipment equal in quantity or complexity to this work.

C. Structural Certification: The seismic resistance capability of all equipment shall be certified by a registered professional engineer in the state in which the project resides. The requirements of Chapter 16 Division III, Earthquake Design, in the latest version of the California Building Code and all other applicable local codes shall be met.

1.11 Product Delivery, Storage And Handling

A. Comply with pertinent provisions of Division 1.

B. Package equipment at factory prior to shipping using manufacturer's standard method.

C. Protect equipment during transit, storage and handling to prevent damage and deterioration. Comply with requirements of manufacturer's instructions.

D. Identify each base or vibration isolation or seismic restraint item with individual tag numbers which correlate with the equipment tag system used on shop drawings.

1.12 Project Conditions

A. Field Measurements: Check actual equipment sizes by accurate field measurements before fabricating bases or vibration isolation and seismic restraint equipment. Show resulting measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in installation.

B. Discrepancies: Note all discrepancies in surrounding construction which are likely to affect the operational or structural performance of the equipment. Provide a list of such discrepancies to the Contractor and directly to the Architect.

1.13 Warranty

A. Bases, vibration isolation equipment, and seismic restraint equipment shall be warranted against defective workmanship, operation and materials for the life of the equipment supported by these items.

PART 2 - Products

2.1 Acceptable Manufacturers

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

1. M. W. Saussé and Co., Saussé, Valencia, California
2. Mason Industries Inc., Mason, Los Angeles, California
3. Amber/Booth Company, A/B, Houston, Texas

2.2 Vibration Isolation Materials
A. The listing of a Manufacturer's product in sections below does not certify that it fully complies with these specifications. All modifications of a listed product required to bring it into compliance with these specifications shall be indicated in submittals and made prior to jobsite delivery.

B. Mount P1: Neoprene Pad(s) and Bearing Plate(s): Neoprene pad shall be ribbed or waffled, 5/16 to 1/2 inch thick, 40 durometer, with a minimum 1/16-inch thick steel bearing plate on top. Size pad and bearing plate to receive 60 psi load. Provide single or multiple pads and plates in series as specified, with 1/16-inch-thick steel shim between layers. Provide "NR + plate(s)" by A/B, "W + plate(s) or WM" by Mason, "NPD + plate(s) or NGD" by Kinetics or approved equal.

C. Mount P2: Extra Thick Neoprene Pad(s) and Bearing Plate(s): Neoprene pad shall be waffled, 3/4 inch thick, 30 or 40 or 50 durometer, as scheduled, with a minimum 1/16-inch thick steel bearing plate on top. Pad areas shall be selected so no more than 15% and no less than 10% deflection occurs due to the supported load. Provide single or multiple pads and plates in series as specified with 1/16-inch-thick steel shim between layers. Provide "Super W + plate(s) or SWM" by Mason or approved equal.

D. Mount P3: Neoprene Bushing for Bolt Holes in Pads: Bushings shall be minimum 3/16" thick in all places and maximum 40 durometer. Provide steel washer to distribute bolt head loads to bushing. Provide bushings by Mason or approved equal.

E. Mount B1: Neoprene Mount: Neoprene isolators shall be double-deflection neoprene-in-shear type with steel reinforced base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be supplied in the base and the top shall have a threaded fastener. Neoprene no harder than 50 durometer. Provide "RVD" by A/B, "ND" by Mason, "RD" by Kinetics or approved equal.

F. Mount B1EQ: Neoprene Mount with Integral Seismic Restraint: A neoprene isolator with concentric steel elements separated by neoprene no harder than 50 durometer. Mount capable of acting in tension, compression or shear. Provide "BR" by Mason or approved equal.

G. Mount B2: Unhoused Spring: Springs shall be designed and installed so their ends are parallel before and after installation and during equipment operation. All mounts shall have equipment leveling bolts. Each isolator shall have a steel base plate with mounting bolt holes and a ribbed or waffled neoprene friction pad permanently adhered to the bottom. The pad shall be 5/16 to 1/2 inch thick, 40 durometer hardness, and sized for a load of 60 psi. Provide "SW" by A/B, "SLFH" by Mason, or "FDS" by Kinetics or approved equal.

H. Mount B2VTL: Spring with Seismic Restraint and Vertical Travel Limit: Same as Mount B2 with the addition of steel columns on either side of the spring to provide seismic restraint and accommodate vertical travel limit stops. Mount shall resist a seismic acceleration in any direction of at least 0.5 G or as required by the relevant codes. Travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the limit stops and the spring so as not to interfere with the spring action. Each isolator assembly shall have a friction pad of ribbed or waffled neoprene permanently adhered to the bottom. The pad shall be 5/16 to 1/2 inch thick, 40 durometer hardness, and sized for a load of 60 psi. Provide "CT" by A/B, "SLR" by Mason, "FLS" by Kinetics or approved equal.

I. Mount B3: Air Springs: a complete vibration isolation system consisting of minimum of three airsprings, a total of three height sensing valves and associated interconnecting air tubing. Air tubing and connection shall also be provided to a source of compressed air providing a minimum 100 psi. The air compressor is not included in this work. One height control valve shall be provided at each mounting location. A total of three height control valves shall be provided. If there are two or more air springs per location, they shall be connected to the outlet of the height control valve in parallel. The air spring shall operate at its normal operating height and the maximum pressure shall not exceed the manufacturer's
recommendations. The air system shall maintain an elevation of + 1/8 inch, once adjusted. Height limit stops shall be provided to preclude more than 1/4 inch rise in the event of failure. The vertical natural frequency of the airspring system shall not exceed 1.6 Hertz.

J. Hanger H1: Neoprene Hanger: Vibration isolation hangers shall consist of a double-deflection neoprene-in-shear element contained in a steel housing. It shall be formed with a projecting neck bushing for the hole in the hanger housing that will prevent metal-to-metal contact between the hanger rod and the housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing. Neoprene shall be no harder than 50 durometer. Provide "BRD" by A/B, "HD" by Mason, "RH" by Kinetics or approved equal.

K. Hanger H2: Standard Spring Hanger: Vibration isolation hangers shall contain a laterally-stable steel spring set in a neoprene cup manufactured with a bushing to prevent short-circuiting of the hanger rod as it passes through the hanger housing. The cup shall contain a steel washer designed to properly distribute the spring load on the neoprene and prevent its crushing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the housing. Neoprene cup shall be minimum 1/4 inch thick and maximum 50 durometer. Provide "30" by Mason or approved equal.

L. Hanger H3: Precompressed Spring Hanger: Vibration isolation hangers shall be the same as Mount H2 but shall be delivered precompressed to their planned installed deflection to keep pipes or equipment steady during installation. Hangers shall be designed with a slow-release mechanism to free the spring after installation is complete and the spring is fully loaded. Great care shall be taken to see that all springs are free to oscillate 0.25". Deflection shall be clearly indicated by means of a scale. Provide "PC30" by Mason or approved equal.

M. Hanger H4: High-Deflection Spring Hanger: Same as Mount H2 with addition at top of hanger housing of double-deflection neoprene -in-shear element no harder than 50 durometer and with total deflection capability up to 5 inches. Provide "30N or 30N-400" by Mason or approved equal.

N. Hanger H5: High-Deflection Precompressed Spring Hanger: Same as Mount H3 with addition at top of hanger housing of double-deflection neoprene-in-shear element no harder than 50 durometer and with total deflection capability up to 5 inches. Provide "PC30N or PC30N-400" by Mason or approved equal.

O. Curb C1: Standard Vibration Isolation Curb: Vibration isolation curb shall be a prefabricated assembly consisting of an extruded aluminum frame and spring vibration isolation system. The aluminum frame shall be sufficiently rigid to support the equipment load without detrimental deflection. Frame and spring connections to include resilient snubbing to resist wind and seismic forces. Spring isolators shall be selected and positioned along the two long sides of curb no closer than 7’ apart to achieve the minimum static deflection called for in the schedule. The static deflection of each individual isolator shall differ from the other by no more than 10%. Galvanizing requirements shall apply to each spring used in the curbs. Provide "CMAB" by Mason, "KSR" by Kinetics or approved equal.

P. Curb C2: High Deflection Vibration Isolation Curb: Vibration isolation curbs shall be a prefabricated assembly consisting of a lower frame of steel tubes topped by steel springs resting on neoprene pads in turn topped with an upper frame which provides continuous equipment support. Upper frame and spring connections to be adjustable and to include resilient snubbing to resist wind and seismic forces. Springs to be galvanized, accessible and stable. Springs shall be placed no less than 7” apart along the 2 long sides of the curb. The static deflection of any individual spring shall differ from the others by no more than 10%. It shall be possible to replace individual springs while the isolated equipment is operating normally, without affecting its performance. Provide "RSC" by Mason or approved equal.

2.3 Base Materials
A. **Base BS1: No Frame Required for Floor Mounting:** This base mounting method shall be used only with small pieces of equipment that have an integral casing or base frame that is adequately strong to be supported directly on vibration isolators without deforming the casing or frame or affecting equipment or isolator operation to any significant or noticeable extent. Place vibration isolators directly under equipment or connect steel height-saving brackets to the sides of the equipment and place isolators under brackets. Equipment manufacturer shall approve such mounting.

B. **Base BS2: Steel Frame for Floor Mounting:** Steel frames for floor-mounted equipment shall consist of structural steel sections sized, spaced, and connected to form a rigid base that will not twist, rack, deform, or deflect in any manner that will negatively affect the equipment or isolation mounts. Frames shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Frames may be rectangular or tee-shaped in plan. The depth of steel frame base members shall be minimum one-tenth the longest dimension of the base. Frame bases shall include side-mounting height-saving brackets for attachment to vibration isolators. Provide "SFB" by A/B, "WF" by Mason, "SFB" by Kinetics or approved equal.

C. **Base BS3: Inertia Base for Floor Mounting:** Concrete inertia bases for floor-mounted equipment shall be formed of stone-aggregate concrete (150 lb/cu ft) and appropriate steel reinforcing cast between perimeter structural steel sections. Inertia bases shall be built to form a rigid base that will not twist, rack, deform, deflect, or crack in any manner. Inertia bases shall be adequately sized to support basic equipment units and motors plus all attached equipment requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base thickness shall be minimum one-twelfth the longest base dimension but not less than 8 inches. Inertia bases shall include side-mounting, height-saving brackets for attachment of vibration isolators. Minimum clearance between bottom of base and structure beneath must be either 2" or 3% of the shorter base dimension, whichever is greater. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete shall be provided and poured by the Contractor on site. Provide "Custom" by A/B, "K" by Mason, "CIB" by Kinetics or approved equal.

D. **Base BS4: No Frame Required for Ceiling Suspension:** This suspension mounting method shall be used only with small pieces of equipment that have an integral casing with brackets or base frame that is adequately strong to be supported directly from underneath or the lower sides without deforming the casing or frame or affecting equipment or isolator operation to any significant or noticeable extent. Place channels under equipment unit or connect steel brackets to the lower sides of the unit. Suspend channels or brackets from steel rods connected to vibration isolation hangers which are connected to a stiff, heavy part of the structure. Neither channels nor brackets shall exhibit any noticeable deflection or distortion. Also provide slightly slack steel cables for seismic restraint per relevant codes. Equipment manufacturer shall approve such mounting.

E. **Base BS5: Steel Frame for Ceiling Suspension:** Steel base frames for ceiling-suspended equipment shall consist of structural steel sections sized, spaced, and connected to form a rigid base that will not twist, rack, deform, or deflect in any manner that will negatively affect the operation of the supported equipment or vibration isolators. Frames shall be adequately sized to support basic equipment units and motors plus any associated ducts or pipes or electrical elements closely related and requiring resilient support in order to prevent vibration transfer to the building. The depth of the steel frame base members shall be no less than one-twentieth the longest dimension of the base. Equipment shall be rigidly attached to top of frames. Provide "Mason M" or approved equal.

### 2.4 Seismic Restraint Materials

A. **Restraint EQR1: Floor-Mounted Restraint:** Separate earthquake restraints shall be provided for all floor-mounted equipment on vibration isolation mounts that do not include seismic restraint housings. Provide
Vibration Isolation and Seismic Restraints

2.5 Thrust Restraint Materials

A. Restraint TR1: Neoprene Restraint: Thrust restraint shall be custom fabricated using a Type B1 neoprene-in shear isolator and a steel angle. Neoprene isolator bolted to one angle leg opposes equipment thrust; second angle leg bolted to appropriate structure. The steel angle shall be sufficiently rigid and the mounting sufficiently sized and secure to resist the lateral movement of equipment during on-off cycle.

B. Restraint TR2: Steel Spring Restraint: Thrust restraint shall consist of a spring element in series with a neoprene cup. The unit shall be designed to have the same deflection as specified for the base mountings or hangers supporting the equipment. The spring element shall be adjusted in the field to allow for a maximum of 1/4-inch movement during starting or stopping of the equipment. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor. Provide "WBI or WBD" by Mason or approved equal.

2.6 Piping Isolation Materials

A. Connector FPC: Flexible Pipe Connectors: Flexible pipe connectors shall be fabricated of multiple plies of nylon cord, fabric, and neoprene, vulcanized so as to become inseparable and homogeneous. Straight connectors shall be formed into a double sphere shape. Elbow connectors shall have a single sphere shape at the curve of the unit. Flexible connectors shall be able to accept compressive, elongating, transverse, and angular movements. Flexible connectors shall be selected and specially outfitted if necessary to suit the system temperature, pressure, and fluid type. Connectors for pipe sizes 2 inches and smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings. Control cables shall be provided if required. Provide "MFDEJ" or "SFDEJ" by Mason or approved equal.

B. Anchor RPAG: Resilient Pipe Anchor or Guide: These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements that are specifically designed for providing resilient vertical and/or horizontal support when serving as a pipe anchor or guide. Minimum neoprene thickness 1/2 inch. Maximum neoprene durometer 50. Provide "Custom" by A/B, "ADA/GDA" by Mason, "RSF" by Kinetics or approved equal.

C. Sleeve RPS1: Resilient Pipe Sleeve at Support or Construction Penetration: Sleeve shall consist of a formed and stiffened galvanized steel sleeve lined on the inside with moisture and vermin resistant felt bonded to the metal sleeve and 1/2 inch thick. Sleeve inside diameter shall equal pipe outside diameter.
in each application. Sleeve shall be split longitudinally so it can be snapped over pipes and reclosed without damage. Sleeve lengths shall be as recommended by the manufacturer for the given diameters, but shall not be less than 3 inches. Provide "PR-Isolator" by Porter-Roemer, "Trisolator" by Stoneman Engineering or approved equal.

D. Sleeve RPS2: Resilient Pipe Sleeve at Construction Penetration: This unit shall consist of two bolted pipe halves with 3/4 inch or thicker neoprene sponge bonded to the inner faces. The seal shall be tightenable around the pipe to eliminate clearance between the inner sponge face and the piping. Sleeve shall be 2 inches longer than the thickness of the construction it penetrates. Where pipe temperatures exceed 240oF, use 10-pcf-density glass fiber insulation in lieu of sponge neoprene. Provide Mason "SWS", Kinetics “PS-1-D", or approved equal.

E. Hanger FLCH: Clevis Hanger with Felt Lining. The felt material shall be a minimum 1/4" thick and shall extend above the center-line of the suspended pipe. The felt material shall withstand a maximum temperature of 650 degrees F. The finish of the hanger shall be as specified for other clevis hangers utilized for the plumbing piping system. The isolator shall be Tolco “Clevis Hanger with Felt Lining” or approved equal.

2.7 Flexible Duct Connector Materials

A. Fabricate flexible sleeves for connecting ducts to fans of neoprene-impregnated fabric or loaded vinyl, as scheduled. Sleeve material shall be impervious to air. Loaded vinyl shall weigh minimum 1 pound per square foot and shall be "KNC-100B" by Kinetics or equal.

2.8 Flexible Electrical Connector Materials

A. Make flexible electrical connections to all vibrating equipment so as to prevent any vibration transfer to the building.

B. Alternate No. 1: Employ flexible electrical conduit installed grossly slack.

C. Alternate No. 2: Employ flexible expansion/deflection conduit couplings sized for the application (1- to 6-inch diameters available). Coupling to have flexible and watertight outer jacket, inner grounding strap, flexible plastic inner sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit. Coupling shall be "XD Xpansion/Deflection Coupling" by Crouse-Hinds of Syracuse, New York, or "Type DF Expansion and Deflection Fitting" by Spring City Electrical Mfg. Co. of Spring City, Pennsylvania.

2.9 Custom Resilient and Airtight Sleeve Materials

A. Sleeve shall be custom-fabricated. It shall be formed from pipe or sheet metal that is 1 inch larger in each cross-sectional dimension than the penetrating element and is 2 inches longer than the thickness of the construction penetrated. The annular space between the sleeve and the penetrating element shall be packed tightly with long-fiber glass fiber of 2- to 3-pcf density to within 1/2 inch of the ends of the sleeve. The remaining 1/2-inch space at each end shall be filled completely with acoustical sealant to form an airtight seal. Glass fiber packing by CertainTeed, Manville, or Owens-Corning. Acoustical Sealant by DAP, Tremco or U.S. Gypsum, choice depending on application and as approved by Architect.

PART 3 - Execution

3.1 General Requirements Prior to Installation

A. Prior to installation of vibration isolators, frames, guides, seismic restraints and related materials, the
following conditions shall be met:

1. All submittals for equipment shall be approved by the Architect.
2. Written and oral instructions from the vibration isolation equipment Manufacturer shall be obtained.
3. Any conflicts between trades resulting in unavoidable rigid contact of vibrating equipment piping or ductwork due to inadequate space or other unforeseen conditions shall be brought to the Architect's attention. If these conflicts are not resolved before installation, all corrective work shall be at the Contractor's expense.
4. Any discrepancies between the specifications and field conditions or any changes due to specific equipment selection shall be brought to the Architect's attention. If these discrepancies are not resolved before installation, all corrective work shall be at the Contractor's expense.

3.2 General Requirements for Installation

A. Furnish and install vibration isolators, bases, seismic restraints and related materials and insure the following:

1. No mechanical equipment or piping shall make rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to: roofs, floors, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems. Space all vibration-isolated equipment and isolated components and all vibration isolators (including rods and wires) so as to be entirely free of any contact with any building element in any reasonable operating position.
2. The installation or use of vibration isolators shall not cause any change of position of equipment or piping or ducts that results in stresses in any connections or misalignment of shafts or bearings. In order to meet this objective, equipment, piping, and ducts shall be maintained in a rigid position during installation. The load shall not be transferred to the isolators until the installation is complete and in operational condition.
3. No equipment unit shall bear directly on or be suspended from vibration isolators or brackets unless its own frame or casing is suitably rigid to span between isolators without any significant or noticeable deformation and such support is approved by the manufacturer.
4. All rigidly- or resiliently-installed equipment, piping and ducts shall be capable of resisting seismic input from the building in any direction without damaging the building, equipment or mounting system.

3.3 Installation of Floor- and Rooftop- Mounted Equipment

A. Provide vibration isolation and seismic restraint for base-mounted equipment as scheduled and per all instructions in this specification.

B. Unless otherwise shown or specified, all base-mounted equipment shall be set on 6-inch thick, hardrock concrete housekeeping pads. Vibration isolators and seismic restraints shall be bolted to the housekeeping pad. The pad dimensions shall exceed the equipment footprint (including floor mounts) by at least 12'' in each direction (i.e. 6'' per side).

C. Unless otherwise indicated, a minimum clearance of 1 inch shall be provided between the top of a housekeeping pad or floor or roof and the underside of an equipment unit or steel base frame that is vibration-isolated. The minimum clearance where a concrete inertia block is used shall be 2'' or 3% of the base's smaller dimension, whichever is larger. This space shall be cleaned thoroughly of all dirt and debris.

D. For isolation equipment (Mounts B2 and B2VTL) with neoprene pads bearing directly on structure, fasten the isolator base plates to the building structure with suitable bolts. Isolate steel bolts from steel
base plates with neoprene bushings or washers and sleeves (Mount Type P3) minimum 1/4 inch thick and maximum 40 durometer hardness. Provide steel washers to distribute bolt head loads to neoprene bushings or washers below. Size bolt holes in isolator bases to account for neoprene bushings or sleeves.

E. All bases for pumps shall be of sufficient area to support any required pipe stanchions below pipe elbows.

F. Fans and pumps and their respective motors shall always be mounted on a common base.

G. Vibration isolation curbs shall be made weathertight by sealing with flexible aluminum flashing or closed-cell neoprene or flexible vinyl all around the periphery. This weatherproofing shall in no way inhibit the vibration isolation of the spring elements. A closed-cell sponge gasket shall be provided between the equipment unit and the curb to form a weathertight seal.

3.4 Installation of Ceiling- and Roof-Suspended Equipment

A. Provide vibration isolation and seismic restraint for suspended equipment as scheduled and per all instructions within this specification.

B. Ceiling- or roof-suspended equipment shall be supported from the heaviest possible structure, such as trusses, girders, beams, or joists. If necessary, provide heavy extra sub-structure between the building's existing heavy structure in order to support vibration-isolated equipment. Do not suspend equipment from roof decks or floors without approval of the Architect. Connect vibration isolation hangers directly to, or as close as possible to, heavy structure.

C. Hanger rods shall be aligned and free of contact with hanger boxes.

D. Fans and their respective motors shall always be suspended on a common, stiff frame.

3.5 Installation of Seismic Restraints

A. Size, select, and install all seismic restraints so as to resist seismic forces from the building in any direction without damage to equipment, isolators, restraints, or building. Restraints shall not short-circuit vibration isolators during normal operation. Restraints shall comply with Chapter 16, Section III, Earthquake Design, in the latest version of the California Building Code and all other applicable local codes.

B. One seismic restraint shall be provided for each vibration isolator supporting floor- or rooftop-mounted equipment, pipes or ducts.

C. Seismic restraint cables shall be provided for all vibration isolated ceiling or roof-suspended equipment, pipes or ducts. Adjust cables with care to handle required forces but do not short-circuit isolation.

D. Hanger rods supporting ceiling or roof-suspended equipment shall be reinforced by cross-bracing or sleeves to resist lateral and upward vertical seismic loading.

E. All vibration isolators, seismic restraints, springs with seismic restraint housings, and seismic restraint cables shall be suitably secured to appropriate structure so that the fastenings and structure can handle the seismic load.

3.6 Installation of Thrust Restraints

A. Provide horizontal thrust restraints as scheduled for fans delivering large air quantities and with a tendency to rock back on their spring mounts. Install thrust restraints parallel to the axis of air delivery.
and in pairs on opposite sides of the fan.

3.7 Installation of Resilient Duct Supports

A. Provide resilient support of ducts in locations and on isolators as scheduled and/or as shown on the drawings. Provide seismic restraints for ducts and their suspension systems.

3.8 Installation of Resilient Pipe Supports

A. Unless otherwise specified, provide resilient support for all HVAC and plumbing water pipes throughout the building. No such piping is to come into rigid contact with the building.

B. Where "piping systems" are required to be vibration-isolated in a certain room or for a certain distance from an equipment unit, "piping systems" shall include all pipes, valves, strainers, tanks, converters, and other connected hardware.

C. Support all piping in mechanical equipment rooms on Type B2 or H2 or H3 springs sized for minimum 1-inch static deflection, unless otherwise noted.

D. Support on vibration isolators all piping outside of mechanical equipment rooms which is connected to and within a 30-foot radius of a vibration-isolated piece of equipment. If the piece of equipment is supported on neoprene isolators, support pipes on Type B1 or H1 isolators sized for minimum 0.35-inch deflection. If the piece of equipment is supported on spring isolators, support pipes on Type B2 or H2 or H3 springs sized for minimum 1-inch deflection.

E. Throughout the rest of the building not covered in B or C above, use RPS1 resilient pipe sleeves for support. An alternate to this is 1-inch-thick, 10-pcf-density glass fiber pipe insulation with suitable bearing plates to prevent crushing of insulation and without any steel pin or other rigid connection from plate to pipe through insulation.

F. Provide Type RPS1 or RPS2 or Custom resilient pipe sleeves wherever pipes penetrate construction.

G. Provide Type RPAG resilient pipe anchor/guide where anchors and/or guides are required in horizontal and vertical piping. Connect RPAG units to heavy structure only.

H. Release restraining washers and nuts in order to "free" all precompressed spring hangers.

3.9 Installation of Resilient Pipe Connections to Equipment

A. Piping connected to vibration-isolated equipment shall be installed so that it does not strain or force out of alignment vibration isolators supporting either the equipment or the piping. For all project air-handling units, condensing units, fan coil units, packaged HVAC equipment and pumps, provide Type FPC flexible pipe connectors.

B. For the remaining pipe connections, any flexible connector approved by the Architect is acceptable.

3.10 Installation of Resilient Duct Connections to Equipment

A. Provide flexible connections between ducts and all vibrating equipment. Use neoprene-impregnated fabric material unless loaded vinyl is specifically scheduled.

B. Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection so that duct and opening nearly coincide and are almost equally spaced 3 inches from one another all around. Do not install flexible connection until above requirements are met. Fans or fan
casings and ducts shall be able to move 1 inch in any direction relative to each other without short-circuiting metal to metal or stretching taut the flexible connection.

### 3.11 Installation of Flexible Electrical Connections to Equipment

A. Make flexible electrical connections to all vibrating equipment.

B. Alternate No. 1: Install flexible conduit in a grossly slack, shallow "U" form. Flexible conduit to be at least 3 feet or 20 diameters long, whichever is the longer.

C. Alternate No. 2: The flexible coupling shall be free of any nearby building construction and shall be installed slack and free of strain in any direction.

### 3.12 Installation of Resilient and Airtight Sleeves

A. RPS1 and PPS2 Resilient Pipe Sleeves: Observe requirements in 3.10A1 and 2 above. In lieu of packing and sealant, clamp factory-fabricated sleeve assemblies tightly around penetrating elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before sealing of sleeves to penetrated constructions.

B. Custom Sleeves:

1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below, and vertical framing between and to the sides as required. Provide the above, escutcheon plates, and anything else necessary to make the penetrated structure as solid and massive near the penetrations as away from the penetrations.

2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster, or drywall compound full depth and all around--but only to a maximum width of 1 inch--or the requirements of the above paragraph shall not have been satisfied.

3. Pack the 1/2-inch wide annular opening with glass fiber between metal sleeve and penetrating element full depth all around to a firm degree of compaction. Leave a 1/2-inch deep annular opening free at each end of the metal sleeve; fill this fully with acoustical sealant.
<table>
<thead>
<tr>
<th>Equipment Mark</th>
<th>Design Defn.</th>
<th>Isolator</th>
<th>Frame (See note 1)</th>
<th>Mntg Detail</th>
<th>Seismic Restraint (See notes 2 and 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type</td>
<td>Detail</td>
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<td></td>
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<td>Type</td>
<td>Detail</td>
<td>Type</td>
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<tr>
<td>All Air-Handling Units (see notes 4 and 5)</td>
<td>1”</td>
<td>B2</td>
<td>M-5</td>
<td>BS2</td>
<td>M-6</td>
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<tr>
<td>All Chillers</td>
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<td>M-5</td>
<td>BS2</td>
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<tr>
<td>All Cooling Towers</td>
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<td>M-5</td>
<td>BS2</td>
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<tr>
<td>All Exhaust Fans</td>
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<td>M-5</td>
<td>BS2</td>
<td>M-6</td>
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<tr>
<td>All Fan Coil Units</td>
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<td>H2</td>
<td>M-5</td>
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</tr>
<tr>
<td>All Pumps</td>
<td>1”</td>
<td>B2</td>
<td>M-5</td>
<td>BS3</td>
<td>M-6</td>
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</tbody>
</table>

NOTES:
1. Frame may be omitted if a written undertaking can be obtained from equipment manufacturer, stating that factory-supplied frame will be suitable for isolator point-loading and will be adequate seismically, per local Code requirements.
2. Where type B2VTL spring mounts with vertical travel limit stops are specified, seismic snubbers may be omitted if a Licensed Structural Engineer verifies that limit stop on B2VTL mount will provide sufficient seismic restraint to conform with local Code requirements.
3. Provide seismic restraint calculations for all connections of equipment to support structure.
4. Thrust restraints providing 1-inch deflection shall be installed on equipment when the air thrust is greater than 10 percent of the equipment weight.
5. Units shall be mounted on 4-inch (minimum) high concrete housekeeping pads.

HVAC EQUIPMENT VIBRATION ISOLATION SCHEDULE

<table>
<thead>
<tr>
<th>Description of Piping Vibration Isolation</th>
<th>Design Defn.</th>
<th>Isolator</th>
<th>Mntg Detail</th>
<th>Seismic Restraint</th>
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<tr>
<td>Chilled, Condenser, Process Cooling and Hot Water Supply and Return (1” or greater diam.):</td>
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<tr>
<td>Main Horizontal Runs:</td>
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<tr>
<td>Location Description</td>
<td>EQR2</td>
<td>M-4</td>
<td>M-SV3</td>
<td>M-SV4</td>
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<tr>
<td>--------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Suspended (1st 3 points)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended (subsequent points up to a 30 feet radius away from equipment)</td>
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<td>H2</td>
<td>M-4</td>
<td>M-SV3</td>
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<tr>
<td>Suspended (subsequent points beyond 30 foot radius from equipment)</td>
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<td>M-SV3</td>
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<td>B2VTL</td>
<td>M-5</td>
<td>M-SV4</td>
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<td>Wall or Floor Penetration:</td>
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<tr>
<td>Chilled, Process Cooling and Hot Water Supply and Return (less than 1” diam.):</td>
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<tr>
<td>Wall or Floor Penetration:</td>
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</tr>
</tbody>
</table>

**NOTES:**

8. Static deflection for piping is the same as that for the pump that it is connected to.

**HVAC PIPING VIBRATION ISOLATION SCHEDULE**

**END OF SECTION 23 05 48**
SECTION 23 05 53 - Identification for HVAC

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Mechanical contractor shall be fully responsible to provide the Identification submittal to the NOCCCD for review and approval. This is independent of Engineer review.

C. Product Data: For each type of product indicated.

D. Samples: For color, letter style, and graphic representation required for each identification material and device.

E. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

F. Valve numbering scheme.

G. Valve Schedules: For each piping system to include in maintenance manuals.
1.4 Coordination

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - Products

2.1 General

A. Manufacturers:

1. Craftmark Identification Systems
2. Seton Identification Products
3. MSI Marking Services

2.2 Equipment Labels

A. Metal Labels for Equipment:

1. Material and Thickness: Brass or anodized aluminum, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick and having predrilled holes for attachment hardware.
2. Color Coding:
   b. Background Color: Red.
3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label...
C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 Warning Signs And Labels

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Color Coding:
   1. Background Color: Yellow.
   2. Letter Color: Black.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 Pipe Labels

A. General Requirements for Manufactured Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.
2.5 Duct Labels

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.6 Stencils

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of ¾ inch for access panel and door labels, equipment labels and similar operational instructions.

1. Stencil Material: Brass

2. Stencil Paint: Exterior, gloss, alkyd enamel, black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.7 Valve Tags

A. Valve Tags: Stamped or engraved with 1/8-inch letters for piping system abbreviation and ½ inch sequenced numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve tag schedule shall be included in operation and maintenance data.
2.8 Warning Tags

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as “DANGER”, “CAUTION” or “DO NOT OPERATE.”
4. Color:
   a. Background Color: Yellow.
   b. Letter Color: Black.

PART 3 - Execution

3.1 Preparation

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 General Requirements

A. Provide identification on HVAC piping based on environment. For example, HVAC piping identification for the Plumbing Equipment Room and Mechanical Equipment Room shall be capable of handling the moist and wetted environment requirements.

B. Temperature sensors and thermostats for all de-centralized zones or equipment shall be labeled, on their “face” with the same approved designation of the equipment in controls.

C. Properly identify each piece of equipment and controls pertaining to thereto by nameplates mounted on equipment and controls using round head brass machine screws, pop rivets, or contact cement.

D. Locate equipment labels where accessible and visible.

3.3 Equipment Label Installation

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Provide stick on equipment labels to locate equipment above T-bar type panel ceiling. Equipment labels shall be located in corner of panel closest to equipment.

3.4 Pipe Label Installation

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting"

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine
rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within one foot of each valve and control device.
2. Near each branch connection and riser takeoff.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. On all horizontal runs 20 feet maximum but not less than once in each room at entrance and exit of each concealed space.
7. On all piping above removable acoustical ceilings.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:
   a. Background Color: Green.

2. Heating Hot-Water Piping:
   a. Background Color: Yellow.

3. Condenser-Water Piping:
   a. Background Color: Green.

4. Refrigerant Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.

3.5 Duct Label Installation

A. Locate ductwork labels where ductwork is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within one foot of each control device.
2. Near each branch connection and riser takeoff.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. On all horizontal runs 20 feet maximum but not less than once in each room at entrance and exit of each concealed space.
6. On all ducting above removable acoustical ceilings.

B. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Exhaust Air Ducts:
a. Background Color: Yellow.
b. Letter Color: Black.

2. Supply Air, Return Air and Outside Air:
   a. Background Color: Green.

C. Equipment Labels:
   1. Provide stick on equipment labels to locate equipment above T-bar type panel ceiling
   2. Equipment labels shall be located in the corner of panel closest to equipment.

3.6 Valve-Tag Installation

A. Install tags on valves and control devices in piping systems, except valves within factory-fabricated equipment units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

   1. Valve-Tag Size, Shape and Designation:
      a. Chilled Water: 2 inches, round, “CHW”
      b. Heating Hot Water: 2 inches, round, “HHW”
      c. Condenser Water: 2 inches, round, “CW”
      d. Process Cooling Water: 2 inches, round, “PCW”

   2. Valve-Tag Color:
      a. Natural.

   3. Letter Color:
      a. Black.

C. All above and below grade and interior and exterior valves shall be tagged. Submit valve tag chart to the NOCCCD Representative for review and approval at the completion of the project.

3.7 Warning-Tag Installation

A. Write required message on, and attach warning tags to, equipment and other items where required.

End of Section 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:
   a. Variable-flow hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:
   a. Heat exchangers.
   b. Motors.
   c. Heat-transfer coils.

B. Testing, adjusting, and balancing (TAB) contractor will be responsible to carry out the commissioning requirements specified in Section 230800 and other sections referenced in 230800.

1.3 Definitions


B. TAB: Testing, adjusting, and balancing.

C. TABB: Testing, Adjusting, and Balancing Bureau.

D. TAB Specialist: An entity engaged to perform TAB Work.

1.4 Informational Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and...
other requirements along with proposed alternative.


D. Certified TAB reports.

E. Sample report forms.

F. 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.

1.5 Tab Specialists

A. Subject to compliance with requirements, AABC Certified TAB specialist shall be:

   1. American Air Balance
      4721 East Hunter Avenue
      Anaheim, CA 92807
      Phone: 714-693-3700
      Fax: 714-693-9509
      Web: http://www.americanairbalance.com/

   2. Los Angeles Air Balance Company
      1848 West 11th Street, Unit #N
      Upland, CA 91786
      Phone: 800-429-6880
      Fax: 909-931-4840
      Web: http://www.laairbalance.com/

   3. The Penn Air Group
      5941 Lakeshore Drive
      Cypress, CA 90630
      Phone: 714-220-9091
      Fax: 714-220-1390
      Web: http://www.pennairgroup.com/

1.6 Qualifications Of Tab Contractor And Lead Technician

A. Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. The Contractor will provide the services of a qualified test and balance contractor. The qualifications of the TAB contracting firm shall be submitted, along with the specific qualifications of the lead site technician who will remain on site during all TAB work, within 30 days of notice to proceed. Recent projects shall be listed and described for both the company and the lead technician. Names and
telephone numbers of the project contractors and facility managers will be provided.

C. The NOCCCD Representative must approve in writing the qualifications of both the company and the lead technician.

1.7 Quality Assurance

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.

B. TAB Conference: Meet with Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.
   d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.8 Project Conditions

A. Partial NOCCCD Occupancy: NOCCCD may occupy completed areas of building before Substantial Completion. Cooperate with NOCCCD during TAB operations to minimize conflicts with NOCCCD's operations.

1.9 Coordination

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
B. Perform TAB after leakage and pressure tests on water distribution systems have been satisfactorily completed.

1.10 Commissioning Requirements Under Testing, Adjusting, And Balancing

A. Management:

1. The Commissioning Agent (CA) is hired directly by the NOCCCD.
2. The CA directs and coordinates the commissioning activities and the reports to the NOCCCD’s Representative.
3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the NOCCCD Representative.
5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

B. Commissioning requires the participation of Division 23 Testing, Adjusting and Balancing contractor to ensure that all systems are operating in a manner consistent with the Design Intent.

1. The general commissioning requirements and coordination are detailed in Division 1 and Division 23.
2. Contractor shall be familiar with all parts of Division 1 and Division 23 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. The Test and Balance contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the NOCCCD Representative has signed off on the commissioned systems.

1.11 Commissioning Responsibilities

A. Test and Balance (TAB) Contractor: The commissioning responsibilities applicable to TAB contractor are as follows (all references apply to commissioned equipment only):

1. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the NOCCCD Representative.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
3. General Contractor shall attend a commissioning kickoff meeting and other meetings necessary to facilitate the commissioning process.
4. General Contractor shall provide the Commissioning Provider with normal cut sheets and shop drawing submittals of commissioned equipment.
5. General Contractor shall provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Provider for development of start-up and functional testing procedures.

   a. Typically this will include detailed manufacturer installation and start-up, operating,
troubleshooting and maintenance procedures. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Provider.

b. The Commissioning Provider may request further documentation necessary for the commissioning process.

6. General Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Provider for review.

7. Sub-Contractors and design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

8. General Contractor shall provide limited assistance to the Commissioning Provider in preparing the specific functional performance test procedures. Sub-Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

9. General Contractor shall develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and the pre-functional checklists from the Commissioning Provider for all commissioned equipment. Submit to Commissioning Provider for review prior to startup.

10. During the startup and initial checkout process, execute the mechanical and electrical-related portions of the pre-functional checklists for all commissioned equipment.

11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Provider.

12. Address current Engineer of Record punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

14. Provide skilled technicians to perform functional performance testing under the direction of the Commissioning Provider. Assist the Commissioning Provider in interpreting the monitoring data, as necessary.

15. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Provider, NOCCCD's Representative and Engineer of Record and retest the equipment.

16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

17. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning.

18. Provide training of the NOCCCD Representative’s operating staff using expert qualified personnel, as specified.

19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

20. Execute any deferred functional performance testing, witnessed by the Commissioning Provider, according to the specifications.

21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. TAB Contractor. The duties of the TAB contractor, in addition to those listed in (A) are:

1. Six weeks prior to starting TAB, submit to the NOCCCD's Representative the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The NOCCCD’s Representative will approve the site technician’s qualifications for this project.
2. Submit the outline of the TAB plan and approach for each system and component to the Commissioning Provider, NOCCCD’s Representative and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.

3. The submitted plan will include:
   a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
   b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
   c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
   e. Final test report forms to be used.
   f. Detailed step-by-step procedures for TAB work for each system.
   g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
   h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
   i. The identification and types of measurement instruments to be used and their most recent calibration date.
   j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
   k. Proposed selection points for sound measurements and sound measurement methods.
   l. Details of methods for making any specified coil or other system plant capacity measurements.
   m. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
   n. Details regarding specified deferred or seasonal TAB work.
   o. Details of any specified false loading of systems to complete TAB work.
   p. Details of all exhaust fan balancing and capacity verifications.
   q. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
   r. Plan for formal progress reports (scope and frequency).
   s. Plan for formal deficiency reports (scope, frequency and distribution).

4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the NOCCCD’s Representative and Commissioning Provider.

5. Communicate in writing to the General Contractor and the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

6. Provide a TAB report within two weeks of completion. A copy will be provided to the Commissioning Provider. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations as required under as specified.
7. Provide the Commissioning Provider with any requested data, gathered, but not shown on the draft reports.
8. Provide calibrated instruments to assist Commissioning Provider in conducting calibration checks of sensors and flow meters.
9. Provide a final TAB report for the Commissioning Provider with details, as in the draft.
10. Conduct functional performance tests and checks on the original TAB as dictated by the Commissioning Provider.

PART 2 - Products (Not Applicable)

PART 3 - Execution

3.1 Tab Specialists

A. Subject to compliance with requirements, AABC Certified TAB specialist shall be:

1. American Air Balance
   4721 East Hunter Avenue
   Anaheim, CA 92807
   Phone: 714-693-3700
   Fax: 714-693-9509
   Web: http://www.americanairbalance.com/

2. Los Angeles Air Balance Company
   1848 West 11th Street, Unit #N
   Upland, CA 91786
   Phone: 800-429-6880
   Fax: 909-931-4840
   Web: http://www.laairbalance.com/

3. The Penn Air Group
   5941 Lakeshore Drive
   Cypress, CA 90630
   Phone: 714-220-9091
   Fax: 714-220-1390
   Web: http://www.pennairgroup.com/

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 systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine equipment performance data including fan 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.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. 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.
   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 per 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 gage 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 according to the procedures contained in AABC's "National Standards for Total System Balance".

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to:
   a. Section 230716 "HVAC Equipment Insulation"
   b. Section 230719 "HVAC Piping Insulation"

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, 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) units.

3.5 General Procedures For Balancing Air Systems

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended
testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the 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.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 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 minimum 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. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.

   g. 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 Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

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 the same as described for constant-volume air systems.
   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, rpms, 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.

3.7 General Procedures for Hydronic Systems

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general
preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check makeup water-station pressure gage for adequate pressure for highest vent.
3. Check flow-control valves for specified sequence of operation, and set at indicated flow.
4. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
5. Set system controls so automatic valves are wide open to heat exchangers.
6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

D. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Construction Manager and comply with requirements in Section 232123 "Hydronic Pumps."
3. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

4. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
5. Report flow rates that are not within plus or minus 10 percent of design.

E. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

F. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

G. Set calibrated balancing valves, if installed, at calculated presettings.

H. Measure flow at all stations and adjust, where necessary, to obtain first balance.

I. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

J. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

K. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

L. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

M. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

N. Check settings and operation of each safety valve. Record settings.

3.8 Procedures for Constant-Flow Hydronic Systems

A. Measure water flow at pumps. Use the following procedures:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Construction Manager and comply with requirements in Section 232123 "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 **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.

3.10 **Procedures for Chillers**

A. 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 using instruments furnished by chiller manufacturer.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.

3.11 **Procedures for Cooling Towers**

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling-tower spray pump discharge pressure.
7. Adjust water level and feed rate of makeup water system.

3.12 **Procedures for Heat Exchangers**

A. Adjust water flow to within specified tolerances.
B. Measure inlet and outlet water temperatures.

C. Check settings and operation of safety and relief valves. Record settings.

3.13 Procedures for Motors

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.14 Procedures for Heat-Transfer Coils

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

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. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. 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.

3.15 Duct Leakage Tests

A. Refer to 233113 Metal Ducts, 3.9 Field Quality Control, B Leakage Test for additional requirements.
B. NOCCCD Representative shall witness the duct pressure testing performed by Installer.

C. Verify that proper test methods are used and that leakage rates are within specified tolerances.

D. Report deficiencies observed.

3.16 Tolerances

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.
5. Condenser Water Flow Rate: Plus or minus 10 percent.
6. Process Cooling Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 Reporting

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare bi-weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 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.

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C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of TAB supervisor who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. 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.

11. Nomenclature sheets for each item of equipment.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. Test conditions for fans and pump performance forms including the following:

a. Fan drive settings including settings and percentage of maximum pitch diameter.
b. 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. Water flow rates.
2. Duct, outlet, and inlet sizes.
3. Pipe and valve sizes and locations.
4. Terminal units.
5. Balancing stations.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, 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 rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. 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.
G. Fan Test Reports: For 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 rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

H. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and unit number.
   b. Location and zone.
   c. Duct static pressure in inches wg.
   d. Duct size in inches.
   e. Duct area in sq. ft.
   f. Indicated air flow rate in cfm.
   g. Indicated velocity in fpm.
   h. Actual air flow rate in cfm.
   i. Actual average velocity in fpm.
   j. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
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.

J. Pump Test Reports: For chilled water and heating hot water pumps, 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 rpm.
   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.

K. Instrument Calibration Reports:
1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.19 Inspections

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Verify that balancing devices are marked with final balance position.
      d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Construction Manager.
   2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
   3. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. 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.
   2. If the second final inspection also fails, NOCCCD may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.20 Training of NOCCCD’s Representative Personnel

A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to
ensure that training is completed.

B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of NOCCCD’s Representative personnel for commissioned equipment.

C. TAB: The TAB contractor shall have the following training responsibilities:

1. TAB shall meet for 8 hours with facility staff after completion of TAB and instruct them on the following:
   a. Go over the final TAB report, explaining the layout and meanings of each data type.
   b. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   c. Identify and discuss any systems that are close to or are not meeting their design capacity.
   d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
   e. Other salient information that may be useful for facility operations, relative to TAB.

End of Section 23 05 93
Section 23 07 13 - Duct Insulation

PART 1 - General

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

1.2 Summary
A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and return air.
   2. Indoor, exposed supply and return air.
B. Related Sections:
   1. Section 230716 "HVAC Equipment Insulation."
   2. Section 230719 "HVAC Piping Insulation."
   3. Section 233113 "Metal Ducts" for duct liners.

1.3 Action Submittals
A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

1.4 Informational Submittals
A. Qualification Data: For qualified Installer.
B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 Quality Assurance

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 Delivery, Storage, And Handling

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 Coordination

A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 Scheduling

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - Products

2.1 Insulation Materials

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation
Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 Adhesives

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

2.3 Mastics

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated
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according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-BARRIER Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-BARRIER Permeance: ASTM 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 550.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F (minus 46 to plus 104 deg C).
   4. Solids Content: ASTM D1644, 33 percent by volume and 46 percent by weight.

2.4 Sealants

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      d. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: 20 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various
2.5 Factory-Applied Jackets

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II. when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 Field-Applied Jackets

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size].

3. Finish and thickness are indicated in field-applied jacket schedules.


5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.

2.7 Tapes

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 Securements

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch) thick, 1/2 inch wide with wing seal or closed seal.

1. Products: Subject to compliance with requirements, provide the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. GEMCO; Peel & Press.
   c. Midwest Fasteners, Inc.; Self Stick.

2. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
3. Spindle: [Copper- or zinc-coated, low-carbon steel] [Aluminum] [Stainless steel], fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
4. Adhesive-backed base with a peel-off protective cover.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

1. Products: Subject to compliance with requirements, provide one of the following:
a. AGM Industries, Inc.; RC-150.
b. GEMCO; R-150.
c. Midwest Fasteners, Inc.; WA-150.
d. Nelson Stud Welding; Speed Clips.
e. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

D. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

E. Wire: Stainless steel 0.062-inch soft-annealed.

1. Manufacturers: Subject to compliance with requirements, provide product by:

   a. C & F Wire, or equal.

PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.2 Preparation

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 General Installation Requirements

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 Penetrations

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 Installation of Mineral-Fiber Insulation

A. Blanket Insulation Installation on Ducts: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent
Duct Insulation

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insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of
elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 Duct Insulation Schedule, General

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and return.
2. Indoor, exposed supply and outdoor air.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.7 Indoor Duct and Plenum Insulation Schedule

A. Concealed, round supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1.5 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1.5 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1.5 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1.5 inches thick and 0.75-lb/cu. ft. nominal density.

End of Section 23 07 13
SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - General

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

1.2 Summary
A. Section includes insulating the following HVAC piping systems:
   1. Chilled-water piping, indoors.
   2. Heating hot-water piping, indoors.

1.3 Action Submittals
A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
B. Product Data: Provide thermal conductivity, water-vapor permeance thickness and jacket data.
C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties.

1.4 Informational Submittals
A. Qualification Data: For qualified Installer.
B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
C. Field quality-control reports.

1.5 Quality Assurance

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 Delivery, Storage, and Handling

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 Coordination

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 Scheduling

A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 - Products

2.1 Insulation Materials

A. Products shall not contain CFC, asbestos, lead, mercury, or mercury compounds.

B. Insulation shall meet fire and smoke hazard ratings as tested under procedure ASTM E-84, NFPA 255, and UL 723 and shall not exceed flame spread rating of 25 and maximum smoke developed rating of 50.

C. Phenolic Pipe Insulation - Chilled Water, Heating Hot Water and Process Cooling Water:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dyplast Products. Dytherm Phenolic
   b. Resolco Inc. Insul-Phen Green.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.

3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.

4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.2 Adhesives

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Foster Brand 81-33.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 Sealants

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 Field-Applied Jackets

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. PVC Jacket Color:
   a. Chilled-Water Piping:
      1) Chilled Water Supply: Dark Blue
      2) Chilled Water Return: Light Blue
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Moisture Barrier Jacket:

1. Manufacturer: Pittsburg Corning PITTWRAP or approved equal.
2. 125 mil thick heat-seal multi-ply laminate consisting of three layers of a polymer-modified bituminous compound separated by glass reinforcement and aluminum foil.
2.5 Removable Insulation Jackets

A. Manufacturers:
   1. ThermaXX LLC.
   2. INSULTECH.
   3. Firwin.

B. Insulation:
   1. Glass mat, type E needle fiber, 1” at 11.3 LB/CF.
   2. Maximum Use Temperature 400 deg F.

C. Jacket:
   1. Hot Side
      a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
      b. Estimation of Maximum Use Temperature 550 deg F.
   2. Cold Side
      a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
      b. Estimation of Maximum Use Temperature 600 deg F.

D. Thread:
   1. Does not decompose below 800 deg F.
   2. Does not melt.
   3. Diameter: 0.0114

E. Construction:
   1. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching. The thread must be able to withstand the skin temperatures without degradation.
   2. Hog rings, staples and wire are not acceptable methods of closure.
   3. No raw cut jacket edges shall be exposed.
   4. Jackets shall be fastened using hook and loop (Velcro) straps and 1” slide buckles.
   5. Provide a permanently attached aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
   6. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
   7. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
   8. All jacket pieces which match mating seams must include an extended 2” flap constructed from the exterior fabric and shall be secured using hook & loop closure (Velcro) parallel to the seam.
   9. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

2.6 Tapes
A. **ASJ Tape:** White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. **Width:** 3 inches.
3. **Thickness:** 11.5 mils
4. **Adhesion:** 90 ounces force/inch in width.
5. **Elongation:** 2 percent.
6. **Tensile Strength:** 40 lbf/inch in width.
7. **ASJ Tape Disks and Squares:** Precut disks or squares of ASJ tape.

B. **FSK Tape:** Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. **Width:** 3 inches.
3. **Thickness:** 6.5 mils.
4. **Adhesion:** 90 ounces force/inch in width.
5. **Elongation:** 2 percent.
6. **Tensile Strength:** 40 lbf/inch in width.
7. **FSK Tape Disks and Squares:** Precut disks or squares of FSK tape.

C. **Tape:** Fiberglass reinforced securing tape.

1. **Scotch Brand Filament Tape or approved equal**
2. **Width:** 1 inch.
3. **Thickness:** 11.5 mils.
4. **Adhesion:** 90 ounces force/inch in width.
5. **Elongation:** 2 percent.
6. **Tensile Strength:** 40 lbf/inch in width.

D. **PVC Tape:** White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.

2. **Width:** 2 inches.
3. **Thickness:** 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.7 Securements

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch 3/4 inch wide with closed seal.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide product by:

PART 3 - Execution

3.1 Examination

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 General Installation Requirements

A. Insulation shall not be installed until the following have been completed and documentation has been submitted to NOCCCD Representative for approval and record:

1. Cleaning and flushing
2. Pressure testing

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of
voids throughout the length of piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Install rigid pre-insulated pipe supports to protect from compression of insulation material due to point loads.

L. Provide aluminum sleeves at all pipe support joints, between hanger support and exterior layer of insulating systems, to protect from compression of insulation material due to point loads.

M. Install insulation on piping accessories requiring future reoccurring access and service with factory fabricated insulation covers that are easily removed and reapplied.

N. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

P. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches 4 inches o.c.
a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

T. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
5. Handholes.
6. Cleanouts.

3.4 Penetrations

A. Insulation Installation at Underground Exterior Wall Penetrations:

1. Terminate insulation with sleeve seal at wall penetration.
2. Seal terminations with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
3. Above Ground Vertical Riser Clamp:
a. Manufacturer shall be Pipe Shields Inc. Model E2100.
b. Carbon steel pipe material, steel straps and base that is compliance with ASTM A36.
c. Insulation shall be calcium silicate, asbestos free, treated with water repellant.
d. Jacket shall be galvanized steel that is in compliance with ASTM A-527.
e. Fasteners shall comply with ASTM A-307 plated.
f. Coating shall be primer coated.

3.5 General Pipe Insulation Installation

A. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

B. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 Installation of Phenolic Insulation

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.7 Field-Applied Jacket Installation

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install as follows:
   1. With 1-inch overlap at longitudinal seams and end joints; for horizontal applications.
   2. Seal with manufacturer's recommended adhesive.
   3. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 Field Quality Control

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 Piping Insulation Schedule, General

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

3.10 Aboveground Piping Insulation Schedule

A. Chilled Water Supply and Return, 39ºF and above:
   1. All Pipe Sizes: Phenolic Insulation.
      a. Indoor: 1-1/2 inches thick.

B. Heating Hot Water Supply and Return, 200 Deg F and below:
   1. All Pipe Sizes: Phenolic Insulation.
a. Indoor: 2 inches thick.
b. Outdoor: 2 inches thick.

C. Process Cooling Water Supply and Return, 60°F and below:
   1. All Pipe Sizes: Phenolic Insulation.
      a. Indoor: 1 inches thick.

3.11 Indoor, Field-Applied Jacket Schedule

A. Install jacket over insulation material.

B. Piping, Exposed - Chilled and Heating Hot Water:
   1. PVC, Color-Coded by System: 30 mils thick for all indoor applications.

End of Section 230719
Section 23 08 00 - Mechanical Systems Commissioning Requirements

PART 1 - General

1.1 Description

A. The purpose of this section is to specify responsibilities of this Division in the commissioning process.

B. The systems to be commissioned are listed in Division 1.

C. Commissioning requires the participation of this Division to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. This Division shall be familiar with all parts of Division 1 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 Responsibilities

A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of this Division are as follows (all references apply to commissioned equipment only):

1. Include and itemize the cost of commissioning in the contract price.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
3. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.
4. Contractors shall provide the CxA with normal cut sheets and shop drawing submittals of commissioned equipment.
5. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.
   a. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the NOCCCD to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
   b. The CxA may request further documentation necessary for the commissioning process.
   c. This data request may be made prior to normal submittals.
6. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CxA for review and approval.
7. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
8. Provide limited assistance to the CxA in preparing the specific functional performance test procedures as specified in the draft Construction Phase Commissioning Plan. Subs shall review
test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

9. Develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and the prefunctional checklists from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup. Refer to Division 1 for further details on start-up plan preparation.

10. During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.

11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

12. Address current Construction Observer punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

14. Perform functional performance testing under the direction of the CxA for specified equipment in Construction Phase Commissioning Plan. Assist the CxA in interpreting the monitoring data, as necessary.

15. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and A/E and retest the equipment.

16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

17. Prepare red-line as-built drawings for all drawings and final as-builds for contractor-generated coordination drawings.

18. Provide training of the NOCCCD’s operating personnel as specified.

19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

20. Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.

21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Mechanical Contractor. The responsibilities of the mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.

2. Assist and cooperate with the TAB contractor and CxA by:

   a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.

   b. Including cost of sheaves and belts that may be required by TAB.

   c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

   d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor which is an input point to the control system.

4. List and clearly identify on the as-built drawings the locations of all air-flow stations.

5. Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.

6. Notify the GC or CxA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the GC
or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

C. Controls Contractor. The commissioning responsibilities of the controls contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Sequences of Operation Submittals. The Controls Contractor’s submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. If clarity from the Engineer is required for completion of the following requirements, the Controls Contractor shall submit requests for information to gain sufficient information to complete the following requirements:

   a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
   b. All interactions and interlocks with other systems.
   c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
   d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers’ stock sequences may be included, but will generally require additional narrative).
   e. Provide detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
   f. The sequences shall include (as applicable) start-up, warm-up mode, normal operating mode, unoccupied mode sequences, shutdown sequences, failure modes, capacity control sequences and equipment staging and temperature and pressure control: setbacks, setups, resets, etc., effects of power or equipment failure with all standby component functions, all alarms and emergency shut downs, and seasonal operational differences and recommendations.
   g. Provide initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
   h. All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal

   a. The control drawings shall have a key to all abbreviations.
   b. The control drawings shall contain graphic schematic depictions of the systems and each component.
   c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
   d. Provide a full points list with at least the following included for each point:

      1) Controlled system
      2) Point abbreviation
      3) Point description: (DB temp, airflow, etc.)
      4) Display unit
      5) Control point or setpoint: (Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
6) Monitoring point: (Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.)

7) Intermediate point: (Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset)).

8) Calculated point: (“Virtual” point generated from calculations of other point values.)

e. The Controls Contractor shall keep the CxA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the TAB contractor in the following manner:

   a. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

   b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CxA prior to TAB.

   c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

5. Assist and cooperate with the CxA in the execution of the functional testing of the controls system, mechanical equipment, electrical equipment and trend logs as specified in the Construction Phase Commissioning Plan.

6. The controls contractor shall provide a signed and dated certification to the CxA and GC upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

7. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

D. TAB Contractor. The duties of the TAB contractor, in addition to those listed above are:

1. Six weeks prior to starting TAB, submit to the GC the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The NOCCCD will approve the site technician’s qualifications for this project.

2. Submit the outline of the TAB plan and approach for each system and component to the CxA, GC and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.

3. The submitted plan will include:

   a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

   b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.

   c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

   e. Final test report forms to be used.
f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).

i. The identification and types of measurement instruments to be used and their most recent calibration date.

j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.

l. Details of whether and how minimum outside air cfm will be verified and set and for what level (total building, zone, etc.).

m. Details of how building static and exhaust fan / relief damper capacity will be checked.

n. Proposed selection points for any specified sound measurements and sound measurement methods.

o. Details of methods for making any specified coil or other system plant capacity measurements.

p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.

q. Details regarding specified deferred or seasonal TAB work.

r. Details of any specified false loading of systems to complete TAB work.

s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

t. Details of any required interstitial cavity differential pressure measurements and calculations.

u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

v. Plan for formal progress reports (scope and frequency).

w. Plan for formal deficiency reports (scope, frequency and distribution).

4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and GC at least twice a week.

5. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

7. Provide the CxA with any requested data, gathered, but not shown on the draft reports.

8. Provide a final TAB report for the CxA with details, as in the draft.

9. Conduct functional performance tests and checks on the original TAB as specified for TAB in the Construction Phase Commissioning Plan.
PART 3 - Execution

3.1. Submittals

A. This Division shall provide submittal documentation relative to commissioning as required in Division 1.

3.2. Startup

A. The mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Division 1. This Division has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning Authority or the NOCCCD.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and GC. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3. Operation And Maintenance (O&M) Manuals

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

1. This Division shall compile and prepare documentation for all equipment and systems covered in this Division and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and Division 1, prior to the training of the NOCCCD’s personnel.

2. The CxA shall receive a copy of the O&M manuals for review.

B. Systems Concepts and Operations Manual that consists of the following: Owner Objectives (by the NOCCCD); Design Narrative and Basis of Design (by designer); Performance metrics, if completed during design; space and use descriptions, single line drawings and schematics for major systems (by designer); control drawings, sequences of control (by contractor); and a table of all set points and implications when changing them, schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown, instructions for energy savings operations and descriptions of the energy savings strategies in the facility, recommendations for re-commissioning frequency by equipment type, energy tracking recommendations, and recommended standard trend logs with a brief description of what to look for in them (all by (CP)).

C. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the controls contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Three copies of the controls training manuals in a separate manual from the O&M manuals.

2. Operation and Maintenance Manuals containing:

   a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall
be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.

b. Full as-built set of control drawings (refer to Submittal section above for details).

c. Full as-built sequence of operations for each piece of equipment.

d. Full points list. In addition to the updated points list required in the original submittals (Part 1 of this section), a listing of all rooms shall be provided with the following information for each room:

1) Floor 
2) Room number 
3) Room name 
4) Air handler unit ID 
5) Reference drawing number 
6) Air terminal unit tag ID 
7) Heating and/or cooling valve tag ID 
8) Minimum cfm 
9) Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic copy on disk of the entire program for this facility.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.

j. Control equipment component submittals, parts lists, etc.

k. Warranty requirements.

l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:

a. Sequences of operation 

b. Control drawings 

c. Points lists 

d. Controller / module data 

e. Thermostats and timers 

f. Sensors and DP switches 

g. Valves and valve actuators 

h. Dampers and damper actuators 

i. Program setups (software program printouts)

4. Field checkout sheets and trend logs should be provided to the CxA for inclusion in the Commissioning Record Book.

D. Special TAB Documentation Requirements. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.

1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.

2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.
E. Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CxA. Refer to Division 1.

3.4. Training Of NOCCCD’s Personnel

A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Division 1 for additional details.

B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of the NOCCCD’s personnel for commissioned equipment. Refer to Division 1 for additional details.

C. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the CxA. Copies of audiovisuals shall be delivered to the NOCCCD.

D. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the CxA with a training plan two weeks before the planned training according to the outline described in Division 1.
2. Provide designated NOCCCD’s personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer’s representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:

   a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
   b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
   c. Discussion of relevant health and safety issues and concerns.
   d. Discussion of warranties and guarantees.
e. Common troubleshooting problems and solutions.
f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
g. Discussion of any peculiarities of equipment installation or operation.
h. The format and training agenda in *The HVAC Commissioning Process, ASHRAE Guideline 0* is recommended.
i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.

10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

11. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

E. Controls Contractor. The controls contractor shall have the following training responsibilities:

1. Provide the CxA with a training plan four weeks before the planned training.
2. The controls contractor shall provide designated NOCCCD’s personnel training on the control system in this facility. The intent is to clearly and completely instruct the NOCCCD’s personnel on all the capabilities of the control system.
3. The trainings will be tailored to the needs and skill-level of the trainees.
4. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The NOCCCD shall approve the instructor prior to scheduling the training.
5. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

3.5. Deferred Testing

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) shall be completed as part of this contract. The CA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

End of Section 23 08 00
Section 23 09 00 – Instrumentation and Controls for HVAC

PART 1 - General

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 Summary

A. This Section includes control equipment for HVAC systems and components, including control components for cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 230960 "Sequence of Operations" for requirements that relate to this Section.

C. Definitions:

3. Analog: A continuously varying signal value (temperature current, velocity, etc.)
4. Application Generic Controller (AGC): A networked device or node that contains a complete, configurable application that is generic in nature and suited for various control tasks. The device manufacturer produces this application. The manufacturer exposes a high number of network variables and configuration properties on the device to allow the specific use of the device to be configured with network tools.
5. Application Specific Controller (ASC): A networked device or node that contains a complete, configurable application that is specific to a particular task. This application is normally produced by the device manufacturer and contains a number of configuration parameters that may be adjusted by network tools.
6. Binary: A two-state system where an "on" condition is represented by a high signal level and an "off" condition is represented by a low signal level.
7. BLCN: Building Level Communication Networks (BLCNs) shall be comprised of a BACnet/IP Local Area Network (LAN) for the interconnection of FLCNs, BACnet devices and operator interfaces using the BACnet data links BACnet/IP (B/IP) or BACnet/Ethernet (ISO 8802.3).
8. Bridge: A device that routes messages or isolates message traffic to a particular segment sub-net or domain of the same physical communication media.
9. Building Automation System (BAS): The complete facility control system comprised of all mechanical system automation, and automatic temperature control, etc., as defined in the contract documents. The BAS is built upon a single network infrastructure based upon BACnet protocol. This infrastructure may include field wiring, BACnet wiring, routers, bridges, raceways, and gateways as required connecting noninteroperable subsystems and devices.
10. Channel: A physical media serving a number of nodes. All nodes on any given channel ‘hear’ messages produced by other nodes on the channel. The network configuration and node application program determines whether or not a device responds to the messages.
11. Control Unit: A BACnet control product that handles multiple inputs and outputs and more than one
Instrumentation and Controls for HVAC

23 09 00 - 2

control loop. May utilize a supplemental general-purpose microprocessor in addition to the standard BACnet chip to perform additional functions or software applications.

12. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and PE switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operation.

13. Custom Application Controller (CAC): Programmable control product that incorporates solid-state components to perform control loops or functions. The application in the controller is custom software produced by the Control System Contractor specifically for the project. These applications shall conform to BACnet functional profiles and interoperability standards. Complete documentation including object diagrams, Device Resource Files (DRF), and External Interface Files (XIF) must be submitted EOR (Engineer of Record) when such devices/controllers are used.

14. Deadband: A temperature range over which no heating or cooling energy is supplied, such as 72-78 degrees F, i.e. as opposed to single point changeover or overlap.

15. Device Resource File: External Interface files and BACnet plug-ins that are required to display manufacturer’s defined network variables or configuration parameters correctly.

16. DDC: Direct digital control.

17. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer.

18. Diagnostic Program: A machine-executable program with instructions used to detect and isolate system and component malfunctions.

19. Domain: A domain is a logical collection of nodes on one or more channels. Communications can only take place among nodes configured in a common domain; therefore, a domain forms a virtual network. Multiple domains can occupy the same channels, so domains may be used.

20. ELCN: An Enterprise Level Communication Network (ELCN) shall be comprised of a BACnet/IP Wide Area Network (WAN) for the interconnection of BLCNs and high level operator interface (HLI) using the BACnet data link BACnet/IP (B/IP).

21. FLCN: Field Level Communication Networks (FLCNs) shall be comprised of BACnet networks of unitary BACnet controllers and devices using the BACnet data link Master Slave/Token Passing (MS/TP).

22. Gateway: A device that contains an I/O software driver to translate data from other protocols to the conforming BACnet standards.

23. Graphical User Interface (GUI): A graphical subset of operator interfaces.

24. HVAC Control Systems: The complete BACnet Control System comprising User Interface, routers, gateways, repeaters, Control Units (CU), software, portable operators terminals, network communications wiring and raceways, and required field hardware, etc.

25. Intelligent Devices: BACnet product that is configured to provide control over a single control loop or to monitor a single or multiple control variable(s); incorporates solid-state components based upon BACNet protocol to perform dedicated functions (ex: actuators, sensors, and switches).

26. Internetwork: Internetwork operator interface and BACnet communication shall be transparent to network architecture.

a. BACnet communication shall be automatically routed to all configured BACnet networks by DDC control devices on the internetwork. Dedicated, stand-alone BACnet routers and/or routing devices shall not be necessary or accepted.

27. Man-Machine Interface (MMI): A graphical, object-oriented method by which an operator is capable of communicating with the system. The Man-Machine interface allows the operator to manage, control, monitor, and configure the system.

28. Network: A system of distributed control devices that are linked together on a communication bus. A network allows sharing of point information between all control devices. Additionally, a network may provide central monitoring and control of the entire system from an MMI/GUI.

29. Node: An intelligent device attached to the network. Usually falls into one of the following
categories - sensor, actuator, ASC, AGC, CAC.

30. Operator Interface: A device combination of hardware and software, (PC, laptop or display terminal) which provides client access to the control system, primarily used for network management, configuration, and diagnostics.

31. Operating System (OS): Software which controls the execution of computer programs.

32. Peripheral: External devices used to communicate to and from a computer. Peripherals include CRT, printer, hard drives, disk drives, modems, etc.

33. Point: Group of data, which corresponds to a hardware input, output, or calculated value.

34. Portable Operator's Terminal (POT): Laptop/tablet device that allows local and remote access to the local control network.

35. Router: A device that routes or forwards messages destined for a node on another subnet or domain of the control network. The device controls message traffic based on node address and priority. Routers may also serve as communication interfaces between different channel media. (i.e., powerline, twisted pair, Ethernet/TCP/IP, and RF)

36. Segment: A set of channels connected by bridges or repeaters. A node sees every packet from every other node on its segment.

37. Sensor: Device capable of measuring the condition or value of a variable.

38. Software: Programs and routines used to extend the capabilities of computers hardware.

39. Subnet: A subnet is a logical collection of up to 127 nodes within a domain. Up to 255 subnets can be defined within a single domain. All nodes in a subnet must be on the same segment. Subnets cannot cross-intelligent routers.

D. Abbreviations

1. AAC Advanced Application Controllers
2. AGC Application Generic Controller
3. ASC Application Specific Controller
4. BAS Building Automation System
5. BC Building Controllers
6. BLCN Building Level Communication Networks
7. CAC Custom Application Controller
8. DDC Direct Digital Controller
9. DRF Device Resource File
10. ELCN Enterprise Level Communication Network
11. FAS Facility Automation System
12. FLCN Field Level Communication Networks
13. FPM Feet per minute
14. GPM Gallons per minute
15. GUI Graphical User Interface
16. I/O Input/Output
17. NFPA National Fire Protection Association
18. OS Operating System
19. OWS Operating Work Station
20. PE Pneumatic-electric
21. PID Proportional Integral Derivative
22. PRV Pressure Reducing Valve
23. PSI(g) Pounds per square inch (gauge)
24. RAM Random Access Memory
25. SA Smart Actuators
26. SS Smart Sensors
27. TCS Temperature Control System
28. TCC Temperature Control Contractor
29. UL Underwriters’ Laboratory
30. VCS Voice Communication System
1.3 System Performance

A. Comply with the following performance requirements:

1. Graphic Display. A minimum of 50 dynamic real-time data points within 10 seconds of the request and shall refresh with current data within 5 seconds.

2. Operator Command. The maximum time between the command of a binary or analog object by the operator and the reaction initialization by the device shall be 5 seconds.

3. Object Command. Devices shall respond to automatic command of a binary or analog object within 2 seconds.

4. Object scan. Changes of state or analog shall be transmitted such that no reporting of a value is more than 15 seconds old.

5. Alarm Response. The maximum amount of time from when an object goes into alarm until it is annunciated at the workstation shall not exceed 20 seconds.

   a. Each workstation on the network shall receive alarms within 10 seconds of other workstations.

6. Program Execution. All programs in all DDC devices shall be able to execute at a minimum of at least one time every second. Program execution time shall be configurable to be consistent with the process under control.

7. Control Loop Performance. All DDC devices shall be able to execute control loops at a frequency at least one time every second. The controller shall update the process value and output generated by this calculation at this same frequency at a minimum.

8. Environmental Conditions. All DDC System components provided under this specification shall operate under ambient environmental conditions of -4°F to 131°F dry-bulb and 10% to 90% relative humidity, non-condensing as a minimum. Sensors and control elements shall be constructed of material suitable and rated for the media sensed under the ambient environmental temperature, pressure, humidity, and vibration conditions encountered for the installed location.

9. Power Conditions. Networked components of the DDC System shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

10. Reporting Accuracy. System shall report values with minimum end-to-end accuracy as listed in Table 1.

   a. Combined system repeatability of sensors, controllers and readout devices for a particular application shall be plus or minus 2% of full scale of the operating range.

   b. Repeatability of overall combined system of sensor, controller and readout device in a control loop application will be plus or minus 5% of full scale of the operating range.

   c. Long-term electronic drift shall not exceed 0.4% per year.

<table>
<thead>
<tr>
<th>PROCESS VARIABLE</th>
<th>REPORTING ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor air temperature</td>
<td>±2.0°F</td>
</tr>
<tr>
<td>Water temperature</td>
<td>±1.0°F</td>
</tr>
<tr>
<td>Delta-T</td>
<td>±0.25°F</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>±2% RH</td>
</tr>
<tr>
<td>Water flow</td>
<td>±2% of full scale</td>
</tr>
</tbody>
</table>

TABLE 1: REPORTING ACCURACY
Water pressure  ±2% of full scale (Note 1)
Electrical Power (A, W, V & PF)  ±2% of reading (Note 2)

NOTE 1: For both Absolute and Differential pressure
NOTE 2: Not including utility-provided meters

1.4 Quality Assurance

A. Provide the following approved DDC System manufacturer:
   1. Johnson Controls.

B. System Integrator shall:
   1. Be in good standing with the Manufacturer.
   2. Have on staff, trained integrators.
   3. Have at least four (4) fully trained staff members at all times.
   4. Provide training class certifications of staff members if requested.
   5. Have direct line of technical support from suppliers.
   6. Employ technicians who have completed factory-authorized training.
   7. Employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. The installing Contractor must be regularly engaged in the service and installation of control systems as specified herein.

D. The installing Contractor shall have an office within 200 miles that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing instruction and routine emergency maintenance service on all system components.

E. The installing Contractor shall have in house capabilities to provide control strategies for whole building control. This includes HVAC, lighting, access, and security applications etc.

F. The installing Contractor shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked control systems.

1.5 Action Submittals

A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
   1. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
   2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. The installing Contractor shall provide project list stating completion of no less than three (3) Chilled Water Central Plants projects of similar size or larger within the past five (5) years, which have BacNET based FAS as specified herein installed by the Contractor. These projects must be on-line and functional such that the system can be observed in full operation.
C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing chillers, cooling tower, pumps, valves and control devices and accessories.


4. Details of control panel faces, including controls, instruments and labeling.

5. Written description of sequence of operation.

6. Schedule of valves including flow characteristics.

7. DDC System Hardware:
   a. A complete bill of materials of all equipment, controllers, devices and sensors to be provided and/or used indicating unique equipment identifier, unique device identifier, manufacturer, model number and quantity.
   b. A Protocol Implementation Conformance Statement (PICS) including a BACnet Interoperability Building Block (BIBB) table for each DDC device included in the submittal.
   c. Manufacturer’s technical data including product specification sheets, performance curves and installation/maintenance instructions. When manufacturer’s cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly called out by other means.
   d. Schematic diagrams for all field sensors and controllers providing floor plans indicating the locations of all sensors, devices and temperature control panels.
   e. Control enclosure details for each enclosure including panel identifier, location, physical layout, dimensions, instrumentation, labels, etc.
   f. Wiring diagrams and schematics for each control enclosure showing power source for each panel, secondary power and network termination as well as all individual terminations, terminal numbers, point type and mnemonic/name.
   g. Wiring diagrams for all equipment, motor starters, relay wiring, equipment interlock, safety circuits, etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and point mnemonics.
   h. Wiring diagrams and schematics for each sensor.

8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

9. Controlled Systems:
   a. Riser diagram showing the physical lay-out of the entire Internetwork.
   b. Riser diagram for each individual BACnet network including the ELCN, and each BLCN and FLCN including:
1) Data link with physical characteristics and configuration.
2) Each BACnet networked DDC device including location, service, device instance, MAC address and network number.
3) Each IP networking device including location, service and IP address.
4) Location of all interface devices including network interface jacks and workstation connections.
5) Location of all MS/TP network termination points and End-of-Line terminations.

c. A schematic control flow diagram of each controlled system showing actual physical configuration and location of all control elements including each hardware point type, controller and mnemonic.
d. A schematic wiring diagram of each controlled system showing actual physical wiring and termination of all control elements including each hardware point type, controller, mnemonic and terminal number.
e. An instrumentation list for each controlled system displaying each control element, name, manufacturer, model and product data sheet number in a tabular format.
f. A complete description of the operation of the DDC System including a specific Sequence of Operation for each controlled system. Sequences of operation shall:

1) Reference the submitted schematic of the controlled system.
2) Refer to equipment and control devices by their specific unique identifiers pursuant with the Contract Documents and the DDC System submittal package.
3) Clearly represent actual application programming methodology and functional control operation not merely a copy of the Contract Document specified sequence of control.
4) Include a concise description of functional system operation under specified normal and failure conditions.
5) Include a complete hardware input and output (I/O) points schedule identifying for each point its instance, type, name/mnemonic, controller, equipment/function, location, termination, and override, alarm and display criteria.

1.6 Informational Submittals

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For Installer and manufacturer.

C. Software Upgrade Kit: For the NOCCCD to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control test reports.
1.7 Closeout Submittals

A. Operation and Maintenance Data: For direct digital control system to include in emergency, operation, and maintenance manuals, include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.8 Delivery, Storage, And Handling

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 Coordination

A. Coordinate location of exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Division 26 to achieve compatibility with starter coils and annunciation devices.

1.10 Warranty:

A. The DDC System Manufacturer shall warranty all DDC controllers to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit’s performance specifications for a period of five (5) years at a minimum.

1. Sensors and field components integral to DDC controllers shall be warrantied to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit’s performance specifications for a period of one (1) years at a minimum.

B. The DDC System Contractor shall warranty the installation of all other DDC materials and labor to be free of defects under normal expected service and use for a period of one (1) year from the date of final acceptance.

C. DDC System failures during the installation warranty period shall be adjusted, repaired or replaced at no additional cost or reduction in service to the NOCCCD. Except in the event of property loss or damage,
warranty service shall be provided during regular working hours Monday through Friday.

PART 2 - Products

2.1 Control System

A. Provide the following approved DDC System manufacturer:
   1. Johnson Controls

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. Control system shall be fully compatible with existing control system on campus.

D. Web server and complete graphics integration shall be provided for all new systems to existing system.

E. Graphic screens shall be provided for all systems included in the Sequence of Operations and Points List.

F. Control equipment and network failures shall be treated as alarms and annunciated.

G. Alarms shall be visually identified via the HTML graphics pages. Overrides and setpoint changes for all points shall be configured via the HTML interface.

H. Alarms shall be annunciated in any of the following manners as defined by the user:
   1. Screen message text
   2. SMS and email message
   3. Graphic with flashing alarm object(s)

I. Alarms shall be logged for a period of no less than 1 week

J. The following shall be recorded by the Web Server for each alarm (at a minimum):
   1. Time and date
   2. Location (building, floor, zone, office number, etc.)
   3. Equipment (cooling tower #, access way, etc.)

2.2 Communication

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to the latest version of ASHRAE/ANSI Standard 135, BACnet.

B. Install new wiring and network devices as required providing a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other
operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in this section. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.

1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.

2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.

3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.

4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.3 BAS Hardware and Software

A. The Control system shall be seamlessly integrated to the existing campus control system.

B. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

C. Scheduling: System shall provide the following schedule options as a minimum:

1. Weekly: Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

2. Exception: Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with
standard schedule for that day of the week.

3. Holiday: Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

D. System Coordination: Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

E. Remote Communication: System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

F. Demand Limiting:
   1. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
   2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment and take other programmatic actions to reduce demand. When demand drops below adjustable levels, system shall restore loads as specified.

G. Maintenance Management: System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits.

H. Sequencing: Application software shall sequence cooling towers, pumps, etc. as specified in Sequences of Operation.

I. PID Control: System shall provide direct and reverse acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

J. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

K. Energy Calculations:
   1. System shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
   2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

L. Anti-Short Cycling: Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

M. On and Off Control with Differential: System shall provide direct and reverse acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

N. Runtime Totalization: System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit.

O. Graphic screens shall be provided for all systems included in the Sequence of Operations and Points List.

P. Control equipment and network failures shall be treated as alarms and annunciated.

Q. Alarms shall be visually identified via the HTML graphics pages. Overrides and setpoint changes for all points shall be configured via the HTML interface.
R. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. SMS and email message
3. Graphic with flashing alarm object(s)

S. Alarms shall be logged for a period of no less than 1 week

T. The following shall be recorded by the Web Server for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (unit #, access way, etc.)

2.4 DDC Control Products

A. General:

1. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in this section.

2. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in latest edition of ASHRAE/ANSI 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet:


2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

3. Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Actuators (SAs): Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

5. Smart Sensors (SSs): Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

6. BACnet Communication:

a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

c. Each AAC and ASC shall reside on a BACnet network using MS/TP Data Link/Physical layer protocol.

d. Each SA shall reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
e. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet network using MS/TP Data Link/Physical layer protocol.

C. Communication.

1. Service Port: Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management: BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing: Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation: Each piece of equipment specified this section shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.

E. Keypad: Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.

G. Serviceability:

1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory:

1. Controller memory shall support operating system, database and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

I. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 3 ft.

J. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of
125% of ASC power consumption.

2.5 Input and Output Interface

A. General: Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

B. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs: Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs: Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Universal Inputs and Outputs: Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.6 Power Supplies and Line Filtering

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

   a. Unit shall operate between 32°F and 120°F. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
   b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.

1. Provide internal or external transient voltage and surge suppression for workstations and controllers.
Surge protection shall have:
2. Dielectric strength of 1000 V minimum
3. Response time of 10 nanoseconds or less
4. Transverse mode noise attenuation of 65 dB or greater
5. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.7 Thermowells

A. When thermowells are required, the sensor and well shall be supplied as a complete assembly including wellhead and Greenfield fitting.

B. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.

C. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.

D. Thermowells shall be constructed of stainless steel, Type 304.

E. Manufacturer shall be BAPI Model BA/4"M304 or approved equal.

2.8 Liquid Immersion Temperature Sensors

A. BAPI Model BA/10K or approved equal.

1. Operating Temperature -40 to 240°F
2. Sensing Element NTC 10K (Type II) Thermistor
3. Accuracy at Calibration Temperature +/- 1 °F

B. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

C. Stainless steel, Type 304, socket with minimum insertion length of 4 inches.

2.9 Outside Air Temperature And Humidity Sensors

A. Vaisala HUMICAP Outdoor Humidity and Temperature Transmitter HMD60YO.

1. Humidity Operating Range 0-100% RH
2. Humidity Output Signal 4 to 20 mA, 0 to 100% linear, proportional
3. Humidity Accuracy +/- 2.0% RH, 0-90% RH
4. Humidity Sensing Element HUMICAP 180
5. Temperature Range -40-140°F
6. Temperature Output Signal 4 to 20 mA, 0 to 100% linear, proportional
7. Temperature Accuracy ± 0.36°F
8. Temperature Sensing Element 1K-ohm Platinum RTD 1/3 Class B IEC 751

B. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. They shall also be provided with a
solar radiation shield.

2.10 Water Differential Pressure Transmitters

A. Water differential pressure sensors shall be Setra Model 2301 transmitters or approved equal.

B. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.

C. Provide:

1. NEMA 1 transmitter housing and locate in accessible local control panels wherever possible.
2. Brass 3-valve manifold assembly with shut-off and shunt valves.

D. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the pressure input signals with the following minimum performance specifications.

- Span: Refer to Points List
- Accuracy: ±0.25% of full scale
- Non-Repeatability: 0.05%
- Non-Linearity: ±0.20%
- Response: 30 to 50 ms
- Temperature Stability: Less than 0.02%FS/°F change
- Output: 4 to 20mA

2.11 Thermal-Energy Meters

A. Onicon System 10-BAC MS/TP BTU Meter.

B. Provide system with flow sensor, temperature sensors, transmitter, indicator and connecting wiring for interface via BACnet MS/TP based system.

C. Electromagnetic, full bore flow sensor (no moving parts) with corrosion-resistant-metal body and transmitter for installation in piping. Onicon F-3100 Series.

1. Design: Total thermal-energy measurement.
3. Minimum Temperature Range: 15 to 250 deg F.

D. Temperature Sensors.

1. Manufactured by Onicon.
2. Solid-state sensors calibrated using NIST traceable temperature standards.
3. Differential temperature accuracy ±0.15°F over calibrated range.

E. Indicator: Solid-state, integrating-type meter for wall mounting.

1. Sixteen character alphanumeric LCD display.
2. Display Data: total energy, total flow, energy rate, flow rate, supply temperature and return temperature.
F. Accuracy: Plus or minus 0.05 percent computing non-linearity.

G. Display: Visually indicates total energy, total flow, energy rate, flow rate, supply and return temperature.

H. Output Interface: BacNET MS/TP compatible transceiver high-speed interface.

2.12 Water Flow Meters

A. Provide George Fisher Signet 2551 Magmeter Flow Sensor or approved equal. Integration shall be through 4-20 mA and pulsed relay contact closure.

B. Controls contractor shall provide 4” industrial cold water flow meter for Cooling Tower Yard.

C. General

1. Operating Range: 0.15 to 33 ft/s
2. Pipe Size Range: 0.5 in. to 36 in.
3. Linearity: ±1% reading plus 0.033 ft/s
4. Repeatability: ±0.5% of reading @ 77 °F
5. Minimum Conductivity: 20 μS/cm

D. Wetted Materials

1. Sensor body/Electrodes and Grounding ring: 316L SS and polypropylene
2. O-rings: FPM
3. Case: PBT
4. Display Window: Polyamide
5. Protection Rating: NEMA 4X/IP65

E. Electrical

1. Power Requirements: - 4 to 20 mA: 24 VDC ±10%, regulated, 22.1 mA max.
2. Frequency: 5 to 24 VDC ±10%, regulated, 15 mA max.
3. Digital (S3L): 5 to 6.5 VDC, 15 mA max.
4. Auxiliary (only required for units with relays): 9 to 24 VDC, 0.4 A max
5. Reverse polarity and short circuit protected
6. Current output (4 to 20 mA): - Loop Accuracy: 32 μA max. error (25 °C @ 24 VDC)
7. Isolation: Low voltage < 48 VAC/DC from electrodes and auxiliary power
8. Maximum Cable: 1000 ft
9. Error condition: 22.1 mA
10. Max. Loop Resistance: 300 Ω
11. Compatible with PLC, PC or similar equipment
12. 4 to 20 mA load needed
13. Frequency Output: - Output Modes: Freq., or Mirror Relay (display version only)
14. Max. Pull-up Voltage: 30 VDC
15. Max. Current Sink: 50 mA, current limited

F. Relay Specifications

1. #1, #2 Type: Mechanical SPDT Rating: 5 A @ 30 VDC max., 5 A @ 250 VDC max.
2. #3 Type: Solid State Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC
3. Hysteresis: User adjustable for exiting alarm condition
4. Alarm On Trigger Delay: Adjustable (0 to 9999.9 sec.)
5. Relay Modes: Off, Low, High, Window, and Proportional Pulse
6. Relay Source: Flow Rate, Resettable Totalizer
7. Error Condition: Selectable; Fail Open or Closed

G. Display
1. Characters: 2 x 16
2. Contrast: User-set in four levels
3. Backlighting (only on relay versions): Requires external 9-24 VDC, 0.4 mA max.

H. Max. Temperature/Pressure Rating
1. Storage Temperature: -4 °F to 158 °F
2. Relative Humidity: 0 to 95% (non-condensing)
3. Operating Temperature: Ambient: 14 °F to 158 °F, Media: 32 °F to 185 °F
4. Maximum Operating Pressure: 150 psi @ 77 °F

I. Standards and Approvals
1. UL, CUL (for display versions with relays).
2. NEMA 4X / IP65 Enclosure (with cap installed).

2.13 Cooling Tower Make-Up Water Control System
A. Controls contractor shall provide necessary interface and integration of cooling tower makeup water control system to campus control system:
   1. Integration:
      a. Monitor unit start/stop and operation.
      b. Alarm messages:
         1) Any valve failure to open or close the valves.
         2) High backwash frequency.

2.14 Cooling Tower Oil Temperature Sensor
A. For cooling tower, provide remote temperature oil sensor capable of sending oil temperature reading to Building Automation System.

2.15 Current Transformers
A. The current transformers shall be provided to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
B. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
C. The current transformers shall meet the following specifications.
1. Frequency Limits: 50 to 400 Hz.
2. Insulation: 0.6 KV Class, 10 KV BIL.
3. Accuracy: ± 1 % at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
4. Provide a disconnect switch for each current transformer.

2.16 Current Sensing Switches

A. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output.

B. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip into range.

2.17 Actuators

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements".
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers shall be Belimo, Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: 40 to 104 deg F.
10. Run Time: 60 seconds.
11. For Cooling Tower, 4A:

   a. All electrical components shall comply with Class 1, Group D, Division II or explosion proof requirements.

2.18 Control Valves

A. Manufacturer shall be Belimo.

B. Control Valves: Factory fabricated, of type, body material and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Butterfly Valves:
1. Maximum close-off or differential pressure of 150 psig, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
3. Disc Type: Nickel-plated ductile iron.
4. Sizing: 1-psig maximum pressure drop at design flow rate.

2.19 Electrical Bulk Materials

A. The controls contractor shall be fully responsible to provide all power and wiring (low voltage, 120 volts, etc.) and conduit (3/4” minimum or as required by electrical codes) for connection of all DDC panels, control valves, sensors and any other DDC components for a completely operational DDC system.

B. Enclosures:
   1. Terminal boxes located indoors shall be rated for NEMA 1
   2. Terminal boxes located outdoors shall be rated for NEMA 4X.
      a. Provide with protective coatings suitable to the environment in which they are to be installed.
      b. All enclosures shall be hinged with lockable doors.

C. Transformers: Provide step-down transformers where control equipment operates at lower than circuit voltage. Transformers serving shall be fed from the fan motor leads, or fed from the nearest distribution panelboard or motor control center, using circuits provided for the purpose. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Size transformers so that 80 percent of the rated capacity equals the connected load. Enclose transformers in a steel cabinet with conduit connections. Provide a disconnect switch on the primary side and a fuse cutout on the secondary side. Transformers shall conform to UL 506.

D. The Controls Contractor shall furnish all electrical relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements. All electrical control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

E. Wiring:
   1. Provide complete electric wiring for all temperature control apparatus, including wiring to transformer primaries, panels, valves, etc.
   2. Control circuit conductors which run in same conduit as power circuit conductors shall have same insulation level as power circuit conductors.
   3. Circuits operating at more than 100 volts shall be in accordance with Division 26.
   4. Circuits operating at 100 volts or less shall be defined as low voltage and shall be run in rigid or flexible conduit, metallic tubing, metal raceways or wireways, armored cable, or multiconductor cable. Use multiconductor cable for concealed accessible locations only. Provide circuit and wiring protection as required by NFPA 70. Aluminum-sheathed cable or aluminum conduit may be used but shall not be buried in concrete.
   5. Conduits:
      a. Refer to Division 26 specifications for different usages of rigid conduit, EMT, or IMT.
      b. All exposed wiring shall be in rigid conduit, minimum 3/4”.
      c. All wiring in return air plenums shall be plenum rated.
      d. All wiring shall be in rigid conduit, minimum 3/4”.
6. For less than nominal 120V service: Cable in control panels for analog loops shall be twisted and shielded two conductor, #16 x 30 stranded with #22 AWG drain wire and aluminum-polyester 100 percent shielding cover for each pair. Cable outside of control panels for analog signal loops shall be single twisted #18 AWG shielded pair. Conductors shall be copper coated with Class B strand. Insulation shall be 30 mils XPLE rated at 300 volts. Cable for digital signals shall be two conductor, #16 x 30 stranded. Each conductor shall be color coded. Each cable shall have polyethylene jacket.

7. Wire for low voltage DC and electronic circuits carrying less than 0.5 ampere, cable of two or more conductors, shall be not smaller than No. 18 AWG stranded copper (shielded).

8. Shield cables carrying analog signals and install in separate conduit from AC power circuits.

9. Terminate cables in solder or screw type terminal strips. Do not tap cables at intermediate points.

10. Color code or number wires, whether individual or in cables, for identification.

11. Cables terminating in screw type terminal strips shall have pressure type connectors conforming to UL 486A. Wire in physical contact with compression screw is not acceptable.

12. All VFD wiring shall be shielded.

2.20 Network Communication Requirements

A. Wired network communication shall follow the published guidelines for twisted pair BacNET network.

B. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.

C. All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and “safed” off in an appropriate manner.

D. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer’s wiring practices.

2.21 Input/Output Control Wiring

A. RTD wiring shall be two-wire or four-wire twisted, shielded, minimum number 22 gauge.

B. Other analog inputs shall be a minimum of number 22 gauge, twisted, (shielding optional).

C. Binary control function wiring shall be a minimum of number 18 gauge.

D. Analog output control functions shall be a minimum of number 18 gauge, twisted, shielded.

E. Binary input wiring shall be a minimum of number 18 gauge.

2.22 Splices

A. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers, which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.
2.23 Conduit and Fittings

A. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

B. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

C. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

D. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.24 Relays

A. Relays other than those associated with digital outputs shall be general-purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

B. Relays associated with digital outputs shall have the ability to override the controlled equipment as a function of the relay. Relays shall be protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2.25 Identification

A. Automatic Control Valve Tags

1. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
2. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
3. Prepare lists of all tagged valves showing location, floor level, and tag number, use. Prepare separate lists for each system. Include copies in each maintenance manual.

B. Wire Tags

1. All multi-conductor cables in all pull boxes and terminal strip cabinets shall be tagged.
2. Provide wire Tags as per Division 26.

C. Conduit Tags

1. Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

D. Miscellaneous Equipment Identification

1. Screwed-on, engraved black lamicoid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
2. Inscription, subject to review and acceptance, indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.
PART 3 - Execution

3.1 Examination

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the NOCCCD’s representative for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the NOCCCD’s representative for resolution before rough-in work is started.

E. The Controls Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the NOCCCD’s representative and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

3.2 Installation, General

A. Install routers and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.

B. Install Intelligent Control Devices, Programmable Controllers, and Application Specific Controllers as herein specified, as needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the HVAC drawings.

C. Install wire, raceway systems, conduit, 24 VDC and/or 24 VAC power supplies and final connections to nodes provided by this contract. Must comply with Division 26 requirements.

D. Provide 120 VAC power to control panel locations. The controls contractor shall be fully responsible to provide all wiring (low voltage, 120 volts, etc.) and conduit (3/4” minimum or as required by electrical codes) for connection of all associated DDC sensors, panels, valves, and any other DDC components for a completely operational DDC system.

E. Install all required devices, sensors, hardware, software, wiring, controllers, etc. including any required and not specifically addressed in this specification but required for system functionality. It shall be the responsibility of the Contractor to provide a complete and functional system.

F. Install all control components in accordance with manufacturer's instructions and recommendations.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.

H. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.
I. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

J. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

K. Connect and configure equipment and software to achieve sequence of operation specified.

L. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

M. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

N. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

O. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

P. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

3.3 Electrical System Installation

A. Comply with all Division 26 Installation Requirements.

B. Install low voltage power and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms
2. Electrical rooms
3. Vertical risers (exception: fire rated continuous closet like a telephone closet)
4. Open Areas where the wiring will be exposed to view or tampering

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls and ceilings.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
3. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
4. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals minimum.

E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire- to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

Instrumentation and Controls for HVAC
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F. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

G. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

H. Set conduits as follows:
   1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
   2. Cap open ends of conduits until conductors are installed.
   3. Where conduit is attached to vibrating or rotating equipment, flexible conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
   4. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

3.4 Cleaning

A. The Controls Contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his (or his subcontracts) control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Controls Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.5 Protection

A. The Controls Contractor shall protect all work and material from damage by his/her work or workers or sub-contractors, and shall be liable for all damage thus caused.

B. The Controls Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Controls Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed. The Controls Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.6 Field Quality Control

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

B. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check control valves. Verify that they are in correct direction.
9. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.7 Adjusting

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves without positioners, following the manufacturer's recommended procedure, so that valve is 100 percent open and closed.

9. Stroke and adjust control valves with positioners, following manufacturer's recommended procedure, so that valve is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.8 Calibration

A. The following devices shall be factory calibrated prior to installation and calibration certificates shall be provided by the manufacturer:

1. Water flow meters
2. Water differential pressure sensors

B. The following devices shall be field calibrated after installation:

1. RTD temperature sensors
2. Current switches

3.9 Demonstration

A. Engage a factory-authorized service representative to train the NOCCCD's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

3.10 Training

A. Provide a minimum of four (4) classroom training sessions, eight (8) hours each, throughout the contract period for personnel designated by the NOCCCD.

B. Train the NOCCCD’s staff to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system, and perform routine diagnostic and troubleshooting procedures.
C. Additional training shall be available in courses designed to meet objectives as divided into three logical groupings; participants may attend one or more of these, depending on the level of knowledge required:

1. Day-to-day Operators
2. Advanced Operators
3. System Managers/Administrators

D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.

E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customer’s site. This training shall be made available in addition to the interactive audio-visual tutorial, provided with the system.

3.11 Commissioning Training of NOCCCD’s Representative Personnel

A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of the NOCCCD’s representative personnel for commissioned equipment.

C. Controls Contractor. The controls contractor shall have the following training responsibilities:

1. Provide the Commissioning Provider with a training plan four weeks before the planned training session(s).
2. The controls contractor shall provide designated the NOCCCD’s personnel training on the control system in this facility. The intent is to clearly and completely instruct the NOCCCD’s personnel on all the capabilities of the control system.
3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the Commissioning Provider. Copies of audiovisuals shall be delivered to the NOCCCD’s Representative.
4. The training will be tailored to the needs and skill-level of the trainees.
5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The NOCCCD’s representative shall approve the instructor prior to scheduling the training with concurrence of A/E and Commissioning Provider.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. There shall be two training sessions:

   a. Training I - Control System. The first training shall consist of eight hours of actual training. This training may be held on-site or in the supplier’s facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student,
using appropriate documentation, should be able to perform elementary operations and describe general hardware and functionality of the system.

b. Training II - Plant Systems. The second session shall be held on-site for a period of eight hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:

1) Specific hardware configuration of installed systems in this plant and specific instruction for operating the installed system.
2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set-points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
3) All trending and monitoring features (values, change of state, totalization, etc.) including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
4) Every screen shall be completely discussed, allowing time for questions.
5) Use of keypad or plug-in laptop computer at the zone level.
6) Use of remote access to the system via phone lines or networks.
7) Graphics generation
8) Point database entry and modifications
9) Understanding DDC field panel operating programming (when applicable)

3.12 Acceptance

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of the NOCCCD's representatives.

B. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the NOCCCD's representative. Such tests shall then be performed as part of the warranty.

End of Section 23 09 00
Section 23 09 60 - Sequence of Operations

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. SUBMITTED SEQUENCE OF OPERATIONS IS PRELIMINARY. THE SEQUENCE OF OPERATION WILL BE ADJUSTED, ADDED TO AND MODIFIED AS REQUIRED BASED ON COMMISSIONING REQUIREMENTS. THE CONTROLS CONTRACTOR SHALL TAKE THIS REQUIREMENT INTO CONSIDERATION WHEN BIDDING THIS PROJECT.

B. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1. Refer to the controls portion of this Specification and the Drawings for a complete understanding of the control sequences.
2. Controls Contractor shall be responsible for coordinating Division 230900 and service representatives of the equipment manufacturers to implement these control sequences along with Division 26.
3. Prior to providing submittals, all field wiring connections shall be determined and shown on the submittals for electrical and controls interface.

C. The objective of this Sequence of Operations is to control the mechanical equipment to satisfy building operational requirements.

D. Utilize the NOCCCD campus Direct Digital Control system to control all mechanical equipment and hardware.

E. Graphic screens shall be provided for all systems included in:

1. This Sequence of Operations.
2. Points list and sequence of operations indicated in the drawings.

F. Related Sections include the following:

1. Section 230900 "Instrumentation and Controls for HVAC" for control equipment and devices and for submittal requirements.

G. Definitions:

1. AHU: Air Handling Unit
2. CHW: Chilled water.
3. CHWR: Chilled water return.
4. CHWS: Chilled water supply.
5. CV: Control valve.
6. CW: Condenser water.
7. CWR: Condenser water return.
8. CWS: Condenser water supply.
9. DDC: Direct digital control.
10. DEG: Degree.
11. DP: Differential sensor.
12. EMS: Energy management system.
13. FC: Fan coil.
14. GUI: Graphical user interface.
15. HHW: Heating hot water.
16. HHWR: Heating hot water return.
17. HHWS: Heating hot water supply.
18. PSID: Pounds per square inch differential.
19. VFD: Variable frequency drive.

1.3 Sequence Of Operations

A. Adjustable Points

1. All values shall be user adjustable through the EMS.

B. Building Hours of Operation

1. The building shall be scheduled in occupied mode between 0800-1800 Monday through Friday.
2. During all other hours the building shall be in unoccupied mode.
3. The operating schedule shall be fully adjustable through the EMS.

C. Air Handling Units Control - Variable Air Volume:

1. System Start:
   a. When the AHU is scheduled off the supply and return fans shall be off, the economizer, minimum outside air, exhaust damper, return damper and chilled water valve shall be closed.
   b. When the EMS sends a signal for the unit to start the supply fan and return fan shall both be enabled.
      1) The supply fan and return fan VFDs shall ramp the fan speed up to minimum speed.
   c. Once fan status is confirmed, the minimum outside air damper, economizer damper, exhaust damper, return damper and chilled water valve shall all be enabled and shall operate according to the programming listed further in the sequence.
   d. Fan CTs shall be wired in series to common terminal block and controlled by common VFD.

2. Building Warm-Up:
   a. One (1) hour (adjustable) prior to occupied mode, the AHU fans shall be enabled and the return air temperature sampled. If the return air temperature is below the warm-up mode setpoint of 68°F (adjustable), the warm-up mode is enabled.
   b. Warm-up mode shall remain enabled until the return air temperature is 1°F (adjustable) above the warm-up mode setpoint for five (5) minutes (adjustable), at which time the
system shall return to the normal mode. Warmup shall also be terminated at the time of building occupancy.

c. During the warmup mode, the chilled water cooling control valve shall be closed, minimum OSA and economizer dampers shall be closed, exhaust air damper shall be closed and mixed air damper shall be open. Restroom exhaust fans shall operate. Return fan will track to an airflow (CFM) differential (adjustable).

d. The heating coil shall be used to supply 75°F to 80°F (adjustable) supply air so as to assist the warmup process.

3. Building Purge Mode:

a. Two (2) hours (adjustable) prior to occupied mode, the AHU shall be enabled and maximum zone space temperature to be sampled. If the maximum zone temperature is above the purge mode setpoint of 78°F (adjustable), the purge mode is enabled.

b. During this mode, all VAV dampers shall be commanded to their maximum design position for the duration, cooling valve shall be closed, OSA and economizer dampers shall be open, exhaust air damper shall be open and mixed air damper shall be closed.

c. Purge mode shall remain enabled until the sampling point is 1°F (adjustable) below the purge mode setpoint for 5 minutes (adjustable) at which time purge shall be terminated. If engaged, this mode shall be terminated when normal occupancy begins.

4. Economizer:

a. The minimum outside air damper shall open and modulate to maintain design minimum OSA setpoint.

b. When the outdoor air enthalpy is less than return air enthalpy, the economizer mode shall be enabled.

c. The mixed air dampers will then be controlled in sequence with the cooling coil to maintain a mixed air temperature of 2°F below discharge air temperature setpoint. The mixed air dampers will slowly modulate towards the full OSA position in an attempt to maintain this mixed air temperature setpoint.

d. Once the damper are at a fully open position, the cooling coil chilled water control valve will then begin to modulate open in order to maintain the discharge air temperature setpoint.

e. The economizer mode shall be disabled with the outside air enthalpy is greater than return air enthalpy.

f. A dead band shall be incorporated to prevent short cycling (enabling and disabling) of the economizer modes.

5. Supply Air Static Pressure:

a. A supply air static pressure sensor shall through the EMS controller with PID vary the speed of the supply fan to maintain air handling unit static pressure.

1) The supply air static pressure setpoint shall be initially set at 1.0”w.c.

b. Static pressure sensors shall be provided and monitored through the EMS, and programmed to be selectable, as means of controlling to worst case SP reference point, and monitored through EMS.

c. Supply Static Pressure Reset:

1) Any time a VAV box damper (from several different zones selected based on their anticipated demand) is 90% open, the setpoint shall slowly increment up to a maximum 0.3” WC above the balanced system setpoint.
2) A software switch shall be provided for these selected zones, so to allow them to be removed from consideration during future building operation.
3) Any time all of the VAV boxes dampers are less than 80% open, the setpoint shall decrement down to a minimum of 0.3" WC below the balanced system setpoint.

d. High Static Limit:
  1) If at any point the supply static pressure sensor reads 2.5"w.c. or greater the high static alarm shall be triggered.
  2) The alarm shall shut down the air handling unit and send a message to the EMS.
  3) The high static alarm shall require manual reset before the AHU can be restarted.

6. Building Pressurization Control:
   a. The return fan shall through the VFD controller vary the speed of this fan to maintain a constant predetermined CFM differential (adjustable) between it and the supply fan CFM.
   b. Building exhaust damper requirements from separate fan systems shall be taken into consideration when determining the constant predetermined CFM differential. The CFM differential shall be based on meeting building pressurization design, as verified by the Testing, Adjusting and Balancing (TAB) contractor.
   c. The building pressurization sensor shall compare building pressure with respect to ambient.
   d. The building pressure sensor in the ceiling plenum shall control the exhaust air damper or exhaust fan to the maintain building static setpoint (+0.05"-adjustable).
   e. As the building pressure rises above the operator defined setpoint (+0.05"-adjustable), the exhaust air damper shall open to maintain desired setpoint or the exhaust fan shall ramp up to maintain desired setpoint.
   f. As the building pressure falls below the operator desired setpoint (+0.05"-adjustable), the exhaust air damper shall close to maintain desired setpoint or the exhaust fan shall ramp down to maintain desired setpoint.

7. Chilled Water Valve Control:
   a. The chilled water valve shall modulate to maintain the supply air temperature setpoint.
   b. Heating and cooling shall not occur simultaneously.
   c. Supply Air Temperature Reset:
      1) The initial supply air temperature shall be 55°F.
      2) The supply air temperature shall be reset based on return air temperature
      3) The table below shows the reset schedule.

<table>
<thead>
<tr>
<th>SAT (°F)</th>
<th>RAT (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>75</td>
</tr>
<tr>
<td>60</td>
<td>72</td>
</tr>
</tbody>
</table>

d. The control valve shall be modulated to the full closed position when the supply fan status indicates the fans as off.

8. Heating Hot Water Valve Control:
   a. The heating hot water valve shall modulate to maintain the supply air temperature setpoint at 55°F.
   b. Heating and cooling shall not occur simultaneously.
   c. The control valve shall be modulated to the full closed position when the supply fan status indicates the fans as off.
Sequence of Operations

9. **Filter:**
   a. An analog pressure sensor will indicate the air pressure drop for each filter bank through the EMS.
   b. An alarm shall be generated when the pressure drop across the pre-filer is 0.5”w.c. and/or 1.0”w.c. across the final filter.

10. **Smoke Detection:**
    a. In the event of smoke detection by the duct smoke detectors an alarm shall be sent to the EMS.
    b. The supply fan shall ramp down and shut off.

11. **Carbon Dioxide, CO2, Control:**
    a. Where applicable, the space CO2 level will be monitored.
    b. If the space CO2 level reaches 900 ppm (adjustable), the economizer will be overridden to bring in 100% outside air.
    c. Once the level drops to 800 ppm, the normal controls will operate.

12. **Override Control:**
    a. If any zone served by the air handler has an after-hours override request (as dictated by the occupant sensors installed in each zone and/or central floor override) the unit shall start. The air handler shall operate for 4 hours under normal operating conditions. After the 4 hours the unit shall shut off.

13. **Alarms**
    a. Critical alarms are generated at the operator workstation when:
       1) If the supply air fan is commanded on and positive status is not received from the current switch after 30 seconds.
       2) Minimum outside air damper is commanded fully open or closed and positive status is not received from the open end switch after 30 seconds.
       3) Economizer damper is commanded fully open or closed and positive status is not received from the open end switch after 30 seconds.
       4) Return air damper is commanded fully open or closed and positive status is not received from the open end switch after 30 seconds.
       5) Relief air damper is commanded fully open or closed and positive status is not received from the open end switch after 30 seconds.
       6) Supply air temperature rises above 60°F for 5 consecutive minutes.
       7) When the duct smoke detector senses product of combustion in the SA duct, then the supply fan is disabled and remain in the off position until the alarm is reset.

D. **Zone Control**

1. **Temperature Sensors:**
   a. Each zone shall have a temperature sensor located in one of the rooms served by the VAV box.
   b. The temperature sensor shall have an initial setpoint of 72°F.
   c. Users shall be able to vary the zone temperature setpoint between 70-75°F (adjustable).
   d. If one space is served multiple temperature sensors, then the worst case temperature sensor
shall be used to control supply air temperature.

e. If one VAV box serves multiple spaces and each spaces has its own temperature sensor, then the average temperature shall be used to control supply air temperature.

f. Temperature sensors shall be blank plate type. NOCCCD shall provide locations where temperature sensors to have local adjustability in high priority areas and no digital read out requirements.

E. VAV Control:

1. Occupied Mode:

   a. Deadband:

      1) There shall be a 5°F deadband between heating and cooling modes.
      2) The deadband shall float with the current zone temperature setpoint.

   b. Cooling Mode:

      1) Temperature Control:

         a) When zone is in occupied mode and the zone temperature is above the zone temperature setpoint, the VAV shall be in cooling mode.
         b) The reheat valve shall be in the fully closed position.
         c) If one space is served multiple temperature sensors, then the worst case temperature sensor shall be used to control supply air temperature.
         d) If one VAV box serves multiple spaces and each spaces has its own temperature sensor, then the average temperature shall be used to control supply air temperature.

      2) VAV Box Damper Control:

         a) The VAV damper shall start at minimum position.
         b) The VAV damper shall modulate between its minimum and maximum positions to maintain the zone temperature setpoint.
         c) The damper shall have a minimum position set by the minimum airflow as indicated on the equipment schedule.
         d) The damper shall have a maximum position of 95%.

   c. Heating Mode:

      1) Temperature Control:

         a) When the zone is in occupied mode and the zone temperature is below the zone temperature setpoint, the VAV shall be in heating mode.
         b) When a VAV enters heating mode, the VAV damper shall modulate to the minimum position.
         c) The reheat valve shall modulate to increase the supply air temperature to meet the zone temperature setpoint.
         d) The supply air temperature shall have a maximum of 95°F during heating mode.
         e) If one space is served multiple temperature sensors, then the worst case temperature sensor shall be used to control supply air temperature.
f) If one VAV box serves multiple spaces and each spaces has its own
temperature sensor, then the average temperature shall be used to control
supply air temperature.

2) VAV Box Damper Control:

a) If the supply air temperature reaches the maximum value and the zone
temperature is still below the setpoint, the VAV damper shall modulate until
it reaches the maximum heating position, as indicated by the maximum
heating CFM on the schedule.

2. Unoccupied Mode:

a. Unoccupied mode shall be defined as any period when the building is scheduled to be in
occupied mode but the zones are not occupied (defined by occupant sensors in each room
as described below). During all hours when the building is not scheduled to be in occupied
mode all VAV dampers and reheat valves shall be in the fully closed position.

b. If all of the rooms in a zone remain unoccupied for 20 minutes, the zone shall enter
unoccupied mode. During unoccupied mode, each zone shall have maximum drift point of
78°F and a minimum drift point of 65°F. If the VAV is within the minimum and maximum
drift points the VAV shall remain at minimum position (heating or cooling). If the
maximum drift point is exceeded the VAV shall enter occupied cooling mode (described
above) and cool the space to 5°F below the maximum drift point. If the minimum drift
point is exceeded the VAV shall enter occupied heating mode (described above) and heat
the space to 5°F above the minimum drift point. At this point in both scenarios the VAV
shall return to unoccupied mode.

c. The lighting control system shall send a signal to the EMS to indicate whether each room is
occupied or unoccupied.

3. Central Override

a. Each floor shall have a centrally located push button installed near the elevators. When
pressed the push button shall enable the associated air handler for the floor. All of the
zones for the floor on which the push button was pressed shall move to the unoccupied
position (either heating or cooling). The zones shall control based on the unoccupied
modes described above. If the air handler serves multiple floors all zones on the other
floors shall remain fully closed. When pressed the push button shall activate a 4 hour timer.
At the end of the 4 hour period the associated air handler shall turn off and all of the
associated zones shall move to the fully closed position. Each push of the push button
shall reset the timer.

4. Occupancy Control

a. Lighting occupancy control system shall be utilized to reduce VAV damper position down
to 10% of design airflow when spaces are unoccupied. Occupancy control system shall be
available for:

1) Class Rooms
2) Conference Rooms
3) Meeting Rooms
4) Offices
5) Lobby

b. Occupancy sensor schedule shall be coordinated with Users.
F. CO2 Control:

1. Provide zone level CO2 sensors in spaces with high density occupant load.
2. Each sensor shall tie into the VAV for associated zone.
3. If any CO2 sensor indicates a zone concentration has exceeded 900 PPM, then an alarm shall be sent to the EMS and the associated VAV damper shall modulate to the full open position.
4. If the VAV is in heating mode, the reheat valve shall move to its minimum position (10% open).
5. The VAV damper shall remain in the full open position until the CO2 concentration in the space has fallen below 800 PPM.
6. If after 10 minutes, the CO2 concentration has not fallen below 800 PPM a second alarm shall be sent to the EMS.
7. At this point, a signal shall be sent to the associated AHU for increased outside air. Once the space CO2 concentration has fallen below 800 PPM the VAV and associated AHU shall return to normal operation.

G. Restroom Ventilation Control:

1. Exhaust fan serving the building restrooms shall be enabled whenever any air handling unit is on.
2. If air handling units are off, then exhaust fan serving the building restrooms shall be disabled.

H. Telecom Rooms:

1. The variable air volume boxes shall be the primary source of cooling when the chilled water system is in operation. The room setpoint of 68°F (adjustable).
2. When the chilled water system is disabled, the closed circuit cooler and the associated fan coil unit shall be enabled:
   a. The fan coil shall be on and shall maintain space temperature setpoint at 68°F.
   b. Provide room temperature sensor and temperature shall be reported back to the EMS.
   c. The condenser water valve for the fan coil shall modulate to maintain the supply air temperature setpoint.
   d. If the fan coil is not operating, then the CW valve shall be fully closed.
   e. If float switch in drain pan is enabled via detection of moisture, then EMS shall close chilled water cooling control valve. Send alarm to operator.
   f. The Controls Contractor shall provide shut down of local CW control valve upon high level alarm. The fan shall remain in operation and the alarm will be generated from separate BMS temperature sensor, should room temperature exceed thresholds.
   g. Provide secondary BMS temperature sensor, which can alarm upon a high temperature threshold is exceeded.

I. Reports:

1. Provide year-around scheduling incorporating holidays and vacations as provided by the NOCCCD.
2. Annunciation of events and occurrences on three levels: routine maintenance, low-level alarm condition; high-level alarm condition.
   a. Maintenance alarms shall annunciate conditions that require routine maintenance, such as dirty filters, or hours of equipment operation reaching elapsed time for scheduled preventive maintenance.
   b. Low-level alarm shall annunciate conditions which reflect inoperability of equipment that would not prevent the HVAC systems from providing service but requires maintenance or repair to re-establish operation such as a failed pump or filter alarm.
   c. High-level alarms shall annunciate conditions which require immediate response in order to
insure provision of building HVAC, or that reflect a catastrophic failure of equipment.

d. Contractor shall submit to the Engineer for review and approval designation of all
   conditions for annunciation. All equipment shall be monitored for elapsed time between
   inspection and service; all status of inoperability shall be monitored; all alarm conditions as
   indicted in this Section shall be monitored by the EMS system. All conditions as indicated
   herein shall annunciate via overriding screen display; display and output shall be submitted
   for review and approval.

J. Trending of system and component operation and completion of trend logs in tabular and graphical
   format suitable for binding in a weekly, monthly, and yearly report. Reports shall consist of full-page
   form-fed output with headers, subheadings, dates, times, instrument numbers, etc. Output shall be
   submitted for review and approval.

PART 2 - Products (Not Applicable)

PART 3 - Execution (Not Applicable)

End of Section 23 09 60
Section 23 21 13 - Hydronic Piping

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section specify pipe and fitting materials manufactured exclusively in the United States, joining methods, special-duty valves, and specialties for the following:

1. Chilled water piping.
2. Heating hot water piping.

1.3 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of the following:

1. All piping data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in the United States.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
3. Air control devices.
4. Hydronic specialties.

C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 Informational Submittals

A. Qualification Data: For Installer.

B. Welding certificates.
C. Field quality-control test reports.

D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 Maintenance Material Submittals

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.7 Quality Assurance

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - Products

2.1 Performance Requirements

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled Water Piping: 125 psig at 100 °F.
2. Heating Hot Water Piping: 100 psig at 200 °F.
3. Process Cooling Water Piping: 80 psig at 100 °F.
4. Condenser Water Piping: 100 psig at 130 °F.
2.2 Copper Tube And Fittings

A. Piping for industrial cold water make up and reclaimed water shall be manufactured exclusively in the United States and meet the following requirements:

1. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

2.3 Steel Pipe and Fittings

A. Piping for all chilled and condenser water piping shall be manufactured exclusively in the United States and meet the following requirements:

1. Steel Pipe: ASTM A 53, black steel with plain ends; ERW, grade B, and wall thickness as indicated in Part 3 "Piping Applications" Article.
4. Forged-Steel Flanges and Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

   b. End Connections: Butt welding, fittings.
   c. Flanges: Raised face, slip-on or flat.

B. Provide branch pipe connection to main pipe using tee fittings.

1. Connect branch tee fittings to the bottom or side of the main pipe based on connection requirements.
2. For up-feed risers, connect the branch to the top of the main pipe.
3. Thread-o-let fitting to main pipe are acceptable for pipe fittings 2 inch and below.
4. Saddle fittings are not acceptable.

C. Grooved Mechanical-Joint Fittings and Couplings - Used For Equipment Connection Only:

1. Manufacturer shall be:

   a. Victaulic Company.
   b. Anvil International, Inc.
   c. Central Sprinkler Company; a division of Tyco Fire & Building Products.

2. Acceptable grooved mechanical-joint for this project is at chiller connection only.
3. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
2.4 Joining Materials

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: Not used on this project.

D. Brazing Filler Metals:
   1. Conform to AWS A5.8.
   2. Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   3. Use 15% silver brazing filler metal without flux.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 Dielectric Fittings

A. General Requirements:
   1. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric connections shall be cast brass union/coupling with 12 inch brass nipples.

2.6 Materials

A. Pipe Support System: System shall be engineered and specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane.
   1. Design system using high density / high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing for support is 1-5/8 inch B22TH or 1-7/8 inch BTS22TH.
   2. Custom design system to fit piping, conduits, equipment, or walkways to be installed and actual conditions of service and loading.
   3. Piping Supports: Provide suitable hangers and supports.

B. Bases: Injection molded high density / high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
   1. Moisture Content: Negligible.
   2. Shrinkage/Swelling Due to Moisture: Negligible.
3. Density: 55.8 lb/cu ft.
4. Insect Resistance: No known insect damage potential.
5. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid: No visual or physical change apparent.
6. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
7. Sized as required by loading conditions and as indicated on the drawings.
8. Shop fabricated with inserts for square tubing or threaded rods as required.
9. Color: Integral black color as molded.
10. Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.

C. Steel Framing:
1. Strut Types: 1-5/8 inch B22TH or 1-7/8 inch BTS22H, as required for loading conditions.
2. Thickness: 12 gage.
3. Form: Roll-formed 3-sided or tubular shape, perforated with 9/16 inch holes at 1-7/8 inch centers on three sides.
4. Finish: Hot dip galvanize in accordance with ASTM A 123 after fabrication, free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets, and other surface blemishes.
5. Do not use tubing or tube steel.

D. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
1. Fabricate of carbon steel where framing is carbon steel; fabricate of stainless steel where framing is stainless steel; finished same as framing.
2. Sizes 2-1/2 inch and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
3. Sizes 3 inch and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.

E. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
1. Carbon Steel: Hot-dip galvanized in accordance with ASTM A 153/A 153M.

F. Above Ground Vertical Riser Clamp:
1. Manufacturer shall be Pipe Shields Inc. Model E2100.
2. Carbon steel pipe material, steel straps and base that is compliance with ASTM A36.
3. Insulation shall be calcium silicate, asbestos free, treated with water repellant.
4. Jacket shall be galvanized steel that is in compliance with ASTM A-527.
5. Fasteners shall comply with ASTM A-307 plated.
6. Coating shall be primer coated.

PART 3 - Execution

3.1 Piping Applications

A. Chilled water piping, aboveground, shall be the following:
1. NPS 2" and smaller shall be drawn temper copper tubing, Type L, wrought-copper fittings and brazed joints. Solder joints is not acceptable per NOCCCD Basis of Design. All piping materials
shall be exclusively manufactured in the United States.

2. NPS 2-1/2" and larger shall be Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All piping materials shall be exclusively manufactured in the United States.

B. Heating hot water piping, aboveground, shall be the following:

1. NPS 2" and smaller shall be drawn temper copper tubing, Type L, wrought-copper fittings and brazed joints. Solder joints is not acceptable per NOCCCD Basis of Design. All elbows shall be full radius. All piping materials shall be exclusively manufactured in the United States.

2. NPS 2-1/2" and larger shall be Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All piping materials shall be exclusively manufactured in the United States.

C. Condenser-water piping, aboveground, all pipe sizes shall be the following:

1. NPS 2" and smaller shall be drawn temper copper tubing, Type L, wrought-copper fittings and brazed joints. Solder joints is not acceptable per NOCCCD Basis of Design. All elbows shall be full radius. All piping materials shall be exclusively manufactured in the United States.

2. NPS 2-1/2" and larger shall be Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All piping materials shall be exclusively manufactured in the United States.

D. Air-Vent Piping:

1. Inlet: Same as service where installed.

2. Outlet: Type K, annealed-temper copper tubing with brazed joints.

3. All piping materials shall be exclusively manufactured in the United States.

3.2 Valve Applications

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.3 Piping Installations

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Paint all welds.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.

G. Install piping at slope 1” per 40'-0”. Provide slope arrows on plan and provide drain valve at low points of system.

H. Provide right angle (90°) fittings for changes of direction in the horizontal plane.

I. Provide industry standard pre-manufactured fittings for all piping distribution system changes in direction, changes in size, branch connections, or at final equipment connections.

J. Provide shut off devices as noted in section 230523 and control valves as noted in the independent controls guidelines.

K. Install above grade piping to be serviceable at points of isolation through and accessible ceiling system or other appropriate means.

L. Provide unions or flanges adjacent to valves, control instrumentation, regulators and at final equipment connections for removal of all appurtenances that may require maintenance or replacement.

M. Provide 6” brass nipple on either side of dielectric union(s). Special attention to be placed on appropriate means of separation between dissimilar metals in order to avoid dielectric deterioration. Avoid piping and conduit systems for different services coming into physical contact with one another.

N. Dielectric gaskets are only allowed when means of joining piping or valves are flanged.

O. Piping shall be pressure tested prior to application of insulation to any piece of the piping system.

P. Coordinate with controls contractor and install all controls instrumentation required so as to be accessible and provided with proper clearance to service and/or replace.

Q. Provide rigid inserts at all pipe support points to prevent compression of insulation.

R. Pipes shall have their ends kept capped and be stored on pallets until the point at which the pipe is installed in its final location. When the pipe is installed in its final location, it shall have a temporary plastic cap put in place whenever active construction is not requiring access to the open end.

S. Preferred:
   1. Provide 45° fittings for changes of direction in the vertical plane, when possible, otherwise use right angle (90°) fittings.
   2. Distribute main utility pipe headers in corridors or common areas for ease of access outside of occupied spaces.
   3. Wedlolets and Threadolets are acceptable for pipes 1” and smaller. Hot tapping is allowed under very specific circumstances and shall be considered on a case by case basis and must be approved by NOCCCD.

T. Disallowed:
   1. Stab-in welded pipe or t-drill branch tees are not allowed.
   2. Bull head fitting connections are not allowed.
   3. Distribution of piping systems through electrical or telecommunication utility rooms is not allowed, unless to provide service to HVAC system designed to control temperature of these rooms.
   4. Flexible pipe isolators are not to be used as a means of correcting the misalignment of piping.
U. Install piping free of sags and bends.

V. Install fittings for changes in direction and branch connections.

W. Install piping to allow application of insulation.

X. Select system components with pressure rating equal to or greater than system operating pressure.

Y. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

Z. Install drains, consisting of a tee fitting, NPS 3/4" ball valve, and short NPS 3/4" threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

AA. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

BB. Install branch connections to mains using tee fittings to main pipe. Connect branch tee fittings to the bottom or side of the main pipe based on connection requirements. For up-feed risers, connect the branch to the top of the main pipe. Saddle fittings are not acceptable.

CC. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

DD. Install unions in piping, NPS 2" and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

EE. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

FF. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

GG. Identify piping as specified in Section 230553 "Identification for HVAC"

HH. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

II. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

JJ. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 **Hangers and Supports**

A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC" Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Section 230548 "Vibration Isolation and Seismic Restraints"

C. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Provide spring hangers to support vertical runs for the first five hangers for all mechanical piping mains connected to pumps.
3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
4. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
2. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
3. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
4. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
5. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at each floor and at 10-foot intervals between floors.

3.5 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. Solder Filler Metals: Not used on this project.

D. Brazing Filler Metals:

1. Conform to AWS A5.8.
2. Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
3. Use 15% silver brazing filler metal without flux.

E. Threaded Joints:

1. Thread pipe with tapered pipe threads according to ASME B1.20.1.
2. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID.
3. 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. Do not use pipe sections that have cracked or open welds.

F. Welded Joints:
2. Paint all welds.

G. Flanged Joints:
1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Use suitable lubricants on bolt threads.

3.6 Hydronic Specialties Installation

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.7 Field Quality Control

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Per Section 232113 “Hydronic Piping”, Hydrostatic Testing Procedures shall be:
   a. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but meeting code requirements as noted below. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   b. As indicated in 2013 California Mechanical Code Section 1201.3.9, piping shall be tested with a hydrostatic pressure of not less than 100 psig, but at least 50psig greater than
operating pressure. Required tests shall be conducted by the contractor in the presence of an authorized inspector. The piping being tested shall remain exposed to the inspector and shall not leak during the test.

c. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.

5. Prepare written report of testing.

D. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment.
7. Verify lubrication of motors and bearings.

E. Installation:

1. Pipe, Duct, Cable, and Conduit Support Systems:
   a. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
   b. The use of wood for supporting piping is not permitted.
   c. Provide supports spaced so deflection of piping does not exceed 1/240 of span.
   d. Install framing at spacing indicated, but in no case at greater than 10 feet on center.
   e. Accurately locate and align bases.
      1) Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
      2) Set isolation pads in adhesive if required by manufacturer's instructions.
      3) Place bases on isolation pads.
      4) Adhere or mechanically attach if required by code.
      5) Where applicable, replace gravel around bases.
   f. Set framing posts into bases and assemble framing structure as indicated.
   g. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.

F. FIELD QUALITY CONTROL

1. When requested by the NOCCCD Representative, provide a factory-trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the design requirements and the manufacturer's installation requirements.

G. CLEANING AND PROTECTION

1. Remove all packaging, unused fasteners, and other installation materials from the project site.
2. Provide protection as required to leave the work in undamaged condition at the time of substantial completion.

3.8 Painting
A. Refer to Division 09 for additional requirements.

B. Field Applied:

1. Paint all exposed mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness. Painting is not required on insulated chilled water piping with color coated PVC jacket.

2. Paint shall be a high performance polyurethane enamel coating system. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal. Acceptable primer manufacturers include Ameron Amershield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal. Provide minimum 5 mils dry film thickness.

End of Section 23 21 13
SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This Section specify special-duty valves and specialties for the following:

1. Heating hot water system.
2. Chilled water system.
3. Condenser water system.
4. Process cooling system.
5. Air vent piping.

1.3 Performance Requirements

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 125 psig at 200 °F.
2. Heating Hot Water Piping: 100 psig at 200 °F
3. Makeup Water Piping: 80 psig at 150 °F.
4. Process Cooling Water Piping: 80 psig at 100 °F.
5. Condenser Water Piping: 100 psig at 130 °F.
6. Air-Vent Piping: 200 °F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of the following:
1. All piping data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in the United States.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
3. Air control devices.
4. Hydronic specialties.

C. Shop Drawings:
   1. Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
   2. Submit in latest version of the AutoCAD.

1.5 Informational Submittals

A. Qualification Data: For Installer.
B. Welding certificates.
C. Field quality-control test reports.
D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 Closeout Submittals

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.7 Maintenance Material Submittals

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.8 Quality Assurance

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - Products

2.1 Performance Requirements

A. Hydronic piping components and installation shall be capable of withstanding the following minimum
working pressure and temperature:

1. Chilled-Water Piping: 125 psig at 200 °F.
2. Heating Hot Water Piping: 100 psig at 200 °F
3. Makeup Water Piping: 80 psig at 150 °F.
4. Process Cooling Water Piping: 80 psig at 100 °F.
5. Condenser Water Piping: 100 psig at 130 °F.
6. Air-Vent Piping: 200 °F.
7. Safety Valve Inlet and Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 **Air Control Devices**

A. Manual Air Vents:

1. Manufacturers:
   a. Hoffman
   b. Or Engineer approved equal.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vent:

1. Manufacturers:
   a. Hoffman Model TS Auto Air Vent
   b. Or Engineer approved equal.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
5. Inlet Connection: NPS 1/2
6. Discharge Connection: NPS 1/4
7. CWP Rating: 100 psig
8. Maximum Operating Temperature: 240 deg F

2.3 **Hydronic Piping Specialties**

A. Y-Pattern Strainers:

1. Manufacturers:
   a. Keckley.
   b. Mueller Steam Specialty.
   c. Spirax Sarco
2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.  
3. End Connections:  
   a. Threaded ends for NPS 2 and smaller.  
   b. Flanged ends for NPS 2-1/2 and larger.  
4. Strainer Screen: 40 mesh startup strainer, 1/8” screen, and perforated stainless-steel basket with 40 percent or greater free area.  
5. CWP Rating: 125 psig.  

B. Spherical, Rubber, Flexible Connectors:  
1. Manufacturers:  
   a. Metraflex.  
   b. Or Engineer approved equal.  
3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.  
5. CWP Rating: 150 psig.  
6. Maximum Operating Temperature: 250 deg F.  

PART 3 - Execution  

3.1 Valve Applications  
A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.  
B. Install throttling-duty valves at each branch connection to return main.  
C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.  
D. Install check valves at each pump discharge and elsewhere as required to control flow direction.  
E. Install safety valves at heating hot water system. Pipe drain to nearest floor drain.  
F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.  

3.2 Piping Applications  
A. Air-Vent Piping:  
   1. Inlet: Same as service where installed.  
   2. Outlet: Type K, annealed-temper copper tubing with brazed joints.  
   3. All piping materials shall be exclusively manufactured in the United States.
3.3  Hydronic Specialties Installation

A. Leakage from automatic air vents may cause damage to ceilings and other finished surfaces. Air vents aid in system filling. Air removal after initial startup is accomplished by air separator. Manual air vents may be a better solution.

B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install piping from air separator, or to expansion tank with a 2 percent upward slope toward tank.

E. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

G. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

End of Section 23 21 16
Section 23 29 23 - Variable Frequency Motor Controllers

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section includes separately enclosed, pre-assembled, combination variable frequency drives (VFD), rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. VFD's serving mechanical equipment shall be provided from one manufacturer.

1.3 Definitions

A. Factory-Installed VFD: A VFD installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed VFD: A VFD installed at project site is not factory installed as an integral component of motorized equipment.

C. Legend:

1. BAS: Building automation system.
2. EMI: Electromagnetic interference.
3. IGBT: Insulated-gate bipolar transistor.
4. LAN: Local area network.
5. LED: Light-emitting diode.
7. NC: Normally closed.
8. NO: Normally open.
9. OCPD: Overcurrent protective device.
10. PID: Control action, proportional plus integral plus derivative.
11. PWM: Pulse-width modulated.
12. TDD: Total demand (harmonic current) distortion.
13. THD(V): Total harmonic voltage demand.
14. VFD: Variable-frequency drives.

1.4 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Factory-installed devices.
   c. Enclosure types and details.
   d. Nameplate legends.
   e. Short-circuit current (withstand) rating of enclosed unit.
   f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
   g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 Maintenance Material Submittals

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 Quality Assurance

Variable Frequency Motor Controllers
23 29 23 - 2 of 9
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. Comply with NFPA 70.

1.8 Delivery, Storage, and Handling
A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers.

1.9 Project Conditions
A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: From 14.0 °F to 104 °F.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140.0 °F.
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by NOCCCD or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify the NOCCCD Representative no fewer than three weeks in advance of proposed interruption of electrical systems.
   2. Indicate method of providing temporary electrical service.
   3. Do not proceed with interruption of electrical systems without the College Representative's written permission.
   4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.10 Coordination
A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
   1. Torque, speed, and horsepower requirements of the load.
   2. Ratings and characteristics of supply circuit and required control sequence.
   3. Ambient and environmental conditions of installation location.

1.11 Warranty
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of start-up.
PART 2 - Products

2.1 Manufacturer

A. ABB

B. Danfoss

2.2 General

A. VFD's serving mechanical equipment shall be provided from one manufacturer.

B. Furnish complete variable frequency drives as specified herein for the equipment designated as variable speed.
   1. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified.
   2. Include inlet air filters.
   3. VFD enclosure shall be:
      a. NEMA 1 for indoor applications and not in mechanical rooms or wet or saturated airstream.
      b. NEMA 3R for outdoors or exposed to ambient conditions.
      c. NEMA 12 for mechanical rooms or rooms with water-filled piping.

C. The VFD shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three phase power for stepless motor speed control from 10% to 100% of the motor's 60 Hz speed. Input voltage shall be as specified on the drawing schedules.

D. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage.

E. The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with adjustable voltage and frequency for stepless motor speed control. The VFD shall maintain a constant V/Hz ratio.

F. The VFD and options shall be tested to ANSI/UL Standard 508. The complete drive, including all specified options, shall be UL or ETL listed.

G. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. The total voltage distortion shall not exceed 5%.

H. PWM type drives shall include EMI/RFI filters that meet EN 61800-3 for First Environment restricted level.

I. The VFD's full load amp rating shall meet or exceed NEC Table 430-150.

J. Protective Features:
   1. Individual motor overload protection for each motor controlled.
   2. Protection against input power undervoltage, overvoltage, and phase loss.
3. Protection against output current overload and instantaneous over current.
4. Protection against overtemperature within VFD enclosure.
5. Protection against overvoltage on the DC bus.
6. Protect VFD from sustained power or phase loss. Undervoltage trip activates automatically when line voltage drops more than 10% below rated input voltage.
7. Automatically reset faults due to undervoltage, overvoltage, phase loss, or overtemperature.
8. Protection against output short circuit and motor winding shorting to case faults, as defined by UL 508.
9. Status lights or digital display for indication of individual fault conditions.
10. Controller capable of operating without a motor or any other equipment connected to the drive output to facilitate start-up and troubleshooting.
11. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients.
   a. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.
   b. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

K. Interface Features:

1. Door mounted Hand/Off/Auto selector switch to start and stop the VFD. In the auto position, the VFD will start/stop from a remote contact closure. In the HAND position, the VFD will run regardless of the remote contact position.
3. Local selector switch, Motor speed is determined by the manual speed control.
4. Power/on light to indicate that the VFD is receiving utility power.
5. Fault light to indicate that the VFD has tripped on a fault condition.
6. Digital meter with selector switch to indicate percent speed and percent load.
7. A set of form-C, dry contacts to indicate when the VFD is in the run mode.
8. A set of from-C, dry contacts to indicate when the VFD is in the fault mode.
9. A 0-10VDC or 4-20 mA output signal to vary in direct proportion to the controller’s speed.
10. VFD to have terminal strip to accept N.C. safety contacts. VFD to safety shut down in drive or bypass mode when contacts open.
11. VFD to accept an additional N.C. contact to interface with the Hand-Off Auto switch for remote Stop/Start control.
12. VFD shall accept an external 0-10 VDC or 4-20 mA speed control signal.
13. VFD shall have Proportional Integral Derivative (PID) loop control for VFD operation and independent PID loop control for NOCCCD use.

L. Adjustments:

1. Maximum speed, adjustable 50 to 100% base speed.
2. Minimum speed, adjustable 0 to 50% base speed.
3. Acceleration time, adjustable 3 to 60 seconds.
4. Deceleration times, adjustable 3 to 60 seconds with override circuit to prevent nuisance trips if deceleration time is set too short.
5. Current limit, adjustable 0% to 105%.
6. Overload trip set point.
7. Offset and gain to condition the input speed signal.
M. Service Conditions:

1. Ambient temperature, 32°F to 105°F.
2. 0% to 95% relative humidity, non-condensing.
3. Elevation to 3,300-feet without derating.
4. AC line voltage variation, -35 to +30% of nominal.

N. Bypass Controller:

1. Service:
   a. Provide bypass for cooling tower and sweeper pump VFD’s.
   b. Bypass is not required for air handling unit, chilled water and condenser water pump VFD’s.

2. Provide a manual door interlocked main fused disconnect switch or circuit breaker, pad lockable in the off position.
4. Drive mode selector and light.
5. Bypass mode selector and light.
7. Bypass LDC display, 2 lines, for programming and status, fault, and warning indications.
8. Requirements:
   a. Motor protection from single phase power conditions. The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication.
   b. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.
   c. The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.
   d. Serial communications – the bypass and VFD shall be capable of being monitored and / or controlled via serial communications. Provide communications protocols for BACnet.
   e. BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. “Pass thru I/O” All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.
   f. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD and bypass shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a
normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD system input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.

g. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.

h. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

i. The bypass control shall be programmable for manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass.

j. There shall be an adjustable motor current sensing circuit for the bypass and VFD mode to provide proof of flow indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and on a relay output contact closure.

k. The bypass controller shall have five (5) programmable digital inputs, and five programmable form C relay outputs.

l. The relay outputs from the bypass shall programmable for any of the following indications:

   1) System started.
   2) System running.
   3) Bypass override enabled.
   4) Drive fault.
   5) Bypass fault.
   6) Bypass H-O-A position.
   7) Motor proof of flow (broken belt).
   8) Overload.
   9) Bypass selected.
  10) Bypass run.
  11) System started (damper opening).
  12) Bypass alarm.
  13) Over temperature.

m. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

n. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

o. The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

p. Class 10, 20, or 30 (selectable) electronic motor overload protection shall be included.

O. Special Features:

1. The following special features shall be included in the VFD enclosure. The unit shall maintain its
UL Listing.

a. VFD shall include a communication port with standard protocols BACnet to match NOCCCD’s Johnson Controls DDC system. Coordinate with DDC manufacturer to provide a seamless interface between the VFD and DDC system.

b. All panels shall be marked for 100,000 AMP short circuit current rating in compliance with UL508c.

2. All power and low voltage terminations into and distribution out of VFD shall be through the bottom of drive cabinet through factory provided knock-outs.

3. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 seconds while starting. The VFD shall provide full motor torque at any selected frequency from 20 Hz to based speed while providing a variable torque V/Hz output at reduced speed. Breakaway torque of 160% shall be available.

4. The VFD shall include current sensors to monitor 2 output phases.

5. The VFD shall continue to operate with reduced output without faulting with input voltage as low as 70% of the nominal voltage and shall provide full rated output for input voltages of 90% of nominal.

6. The VFD shall have a minimum of Class 20 I2t motor overload protection, which shall automatically compensate for changes in motor speed.

7. All VFD’s shall have the same interchangeable customer interface keypad to allow a single programmable keypad to download information to multiple VFD’s during startup procedures.

8. The VFD shall accept up to 3 feedback signals, each with independent scaling.

9. Provide additional hardware points into the VFD and procured by Mechanical properly.

10. Provide few hard wired points that shall be made available for tie into BMS, in addition to communication integration card. Mechanical Contractor shall further coordinate with NOCCCD.

PART 3 - Execution

3.1 Installation

A. Provide factory mounting brackets and attachments for VFD's. Field modification or drilling of enclosures is not permitted. Include mounting brackets and supports to maintain required access.

3.2 Start-Up and Commissioning Service

A. The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for drive field repair shall not be acceptable as commissioning agents.

B. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Included in this service shall be (as a minimum):

1. Verification of contractor wire terminations to the VFD and its optional circuitry.
2. Installation verification for proper operation and reliability of the VFD, the motor being driven, and the building automation system.
3. Conform to training requirements specified elsewhere. In addition, the VFD manufacturer's certified trainer shall provide up to one-hour of customer operator training on operation and
4. Measurement for verification of proper operation on each of the following items:
   a. Motor voltage and frequency. Verification of proper motor operation.
   b. Control input for proper building automation system interface and control calibration.
   c. Calibration check for the following set points (and adjustment as necessary) (1) minimum speed, (2) maximum speed, (3) acceleration and deceleration rates.
   d. VFD manufacturer technician shall document all default and custom drive settings.

5. Submit Start-up and Commissioning Reports.

3.3 Examination

A. Manufacturer/Supplier to verify that jobsite meets factory recommended and code required conditions for proper VFD installation prior to the installation. Additionally, manufacturer/supplier shall make needed recommendations to assure proper installation prior to the installation. Manufacturer/Supplier shall visit jobsite subsequent to the installation to verify VFD’s are installed properly. Items considered shall include as a minimum:

1. Clearance spacing.
2. Temperature, contamination, dust, and moisture of the environment.
3. Separate conduit installation of the motor wiring, power wiring, and control wiring.
4. Installation per the manufacturer's recommendation.
5. Measure voltage rise, time, and magnitude at motor.
6. Cover and protect the VFD from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.
7. VFD input and output power shall be installed in separate conduits.

End of Section 23 29 23
Section 23 31 13 - Metal Ducts

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers.

1.3 Performance Requirements

A. Delegated Duct Design:

1. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces:

1. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.

2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of the following products:
1. Material, liners and adhesives.
2. Sealants and gaskets.
4. Duct pressure and leakage testing instruments and methods.
   a. Mechanical Contractor shall provide duct pressure and leakage testing on all ductwork.
   b. NOCCCD Representative shall verify all duct pressure and leakage tests and provide sign-off.
   c. Mechanical contractor shall submit all test reports to the NOCCCD Representative for review.

C. Shop Drawings:
1. Fabrication, assembly and installation, including plans, elevations, sections, components and attachments to other work.
2. Factory and shop fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Equipment installation based on equipment being used on Project.
10. Locations for duct accessories, including dampers and turning vanes.
   a. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.
11. Hangers and supports, including methods for duct and building attachment, restraints and vibration isolation.
12. Submit in the latest version of the AutoCAD.

1.5 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Sprinklers.
   d. Access panels.

B. Welding certificates.

C. Field quality-control reports.
1.6 Quality Assurance


B. Welding Qualifications: Qualify procedures and personnel according to the following:


C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - Products

2.1 Single-Wall Rectangular Ducts and Fittings

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 Single Wall Round Ducts and Fittings

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. McGill AirFlow LLC.
   b. Spiral Manufacturing Co.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 Sheet Metal Materials

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 Duct Liner

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Armacell LLC.
      b. Aeroflex USA Inc.
      c. Rubatex International, LLC.
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.

2.5 Sealant And Gaskets

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

2. Type: S.
3. Grade: NS.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 Hangers and Supports

A. Hanger Rods: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

2.7 Seismic-Restraint Devices

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Ductmate Industries, Inc.
   3. Hilti Corp.
   4. TOLCO; a brand of NIBCO INC.
   5. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service]
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced
component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - Execution

3.1 Duct Installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.

D. Install round ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory or shop fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

K. Install branch takeoffs with conical fittings or 45 degree entry taps.

L. Provide manual balance dampers at each major branch takeoff and at run outs to diffusers and grilles of supply, return and exhaust ductwork.

M. Provide necessary support for plenums as per SMACNA, which may be above standard ductwork support requirements.
N. Install plenums so as to not impede access to adjacent equipment or portions of the ceilings/rooms in which they are installed.

3.2 Installation Of Exposed Ductwork

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. All galvanized steel exposed to rain or atmospheric moisture at roof to be painted PT-11 or color as indicated by the Finish Schedule.

G. No zinc metals, anchors, components, flashings, or coatings exposed to rain or atmospheric moisture allowed in products or assemblies on the roof.

3.3 Additional Installation Requirements for Commercial Kitchen Hood Exhaust Duct

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold contaminants, and sloped a minimum of 2 percent to drain back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 in horizontal ducts.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 Duct Sealing

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 Hanger and Support Installation
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 Seismic-Restraint-Device Installation

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with OSHPD Edition of SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems with seismic hazard level AA.
   1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid
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prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.7 Connections
A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
   1. Food service exhaust fans shall not have flexible duct connectors.
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 Painting
A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09.

3.9 Field Quality Control
A. Perform tests and inspections.
B. Leakage Tests:
   2. Test the following systems:
      a. All ducts, which include supply air, return air, exhaust air at all pressure classes, shall be pressure tested.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.
C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
D. Contractor shall develop and implement an IAQ Management Plan for the construction and preoccupancy phases of the new building as follows:
1. During construction, meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, and Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
2. Protect stored materials on-site and installed absorptive materials from moisture damage.
3. If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used to each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.

E. Duct system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.10 Start Up

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 Duct Schedule

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round: 12.

2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.
   d. SMACNA Leakage Class for Round: 3.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.
   d. SMACNA Leakage Class for Round: 3.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round: 12.
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2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round: 3.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.
   d. SMACNA Leakage Class for Round: 3.

D. Makeup Ducts:

1. Duct Connected to Fireplace:
   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Round: 12.

E. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class and 2) Air:
   a. Pressure Class: Negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round: 3.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: B.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round: 3.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: B if negative pressure and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round: 3.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel. All galvanized steel exposed to rain or atmospheric moisture at roof to be painted PT-11 or color as indicated by the Architectural Finish Schedule.

G. Liner:

1. Supply and Return Air Ducts: Fibrous glass, Type I. Refer to drawings for liner thickness.
H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   
   a. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.
   
   b. Velocity 1000 fpm or Lower:
      
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 2 with vanes.
   
   c. Velocity 1000 to 1500 fpm:
      
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to-Diameter Ratio: 1.5.

   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   
   b. Rectangular Main to Round Branch: Bellmouth.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   
   b. Velocity 1000 to 1500 fpm: Conical tap.
   
   c. Velocity 1500 fpm or Higher: 45-degree lateral.
End of Section 23 31 13
Section 23 33 00 - Air Duct Accessories

PART 1 - General

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

1.2 Summary
A. Section Includes:
1. Backdraft dampers.
3. Combination fire and smoke dampers.
4. Turning vanes.
5. Flexible connectors.
6. Duct accessory hardware.
7. Duct silencers.

1.3 Action Submittals
A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data:
1. For each type of product indicated.
2. For duct silencers:
a. Acoustical and Aerodynamic Test Data: Submit the following data in tabular form for the Manufacturer's standard proposed product:
   1) Sound trap type and size.
   2) Dynamic insertion loss in octave bands centered at 63Hz through 8000Hz for both forward and reverse flow conditions. Dynamic insertion loss shall be determined in accordance with the latest edition of ASTM E 477 or a test standard approved by the acoustical consultant.
   3) Self-noise sound power levels in same octave bands as above. Self-noise shall be determined in accordance with the latest edition of ASTM E 477 or a test standard approved by the acoustical consultant.
   4) Maximum pressure drop at required air volume.
C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   b. Combination fire-smoke-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   c. Backdraft Damper:
      1) Include leakage, pressure drop, and maximum back pressure data.
      2) Indicate materials, construction, dimensions, and installation details.
      3) Verify damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.4 Informational Submittals

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - Products

2.1 Assembly Description


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 Materials

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet
metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 Backdraft Dampers

A. Manufacturers:
   2. Nailor Industries Inc.
   3. Pottorff; a division of PCI Industries, Inc.

B. Frame: 2-1/4 inches x minimum 0.125 inch 6063-T5 extruded aluminum channel with front flange and galvanized steel braces at mitered corners.

C. Blades:
   3. Orientation: Horizontal.
   4. Material: Minimum 0.070 inch 6063-T5 extruded aluminum.
   5. Width: Maximum 6 inches.

D. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.

E. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

F. Linkage: Minimum 1/2 inch aluminum tie bar with stainless steel pivot pins mounted on blades.

G. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.

H. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.

I. Mounting: Horizontal, air flow horizontal.

J. Finish: Mill aluminum.

K. Performance Data:
   1. Temperature Rating: Withstand -40 to 200 degrees F.
   2. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
      a. Closed Position: Maximum back pressure of 16 inches w.g..
      b. Open Position: Maximum air velocity of 2,500 feet per minute.
   3. Operation of Blades:
      a. Start to Open: 0.01 inch w.g..
      b. Fully Open: 0.05 inch w.g.
4. Pressure Drop: Maximum 0.15 inch w.g. at 1,500 feet per minute through 24 inch x 24 inch damper.

L. Screen:
   1. Type: Insect.
   2. Location: Rear with sleeve.
   3. Material: Aluminum

2.4 Manual Volume Dampers

A. Standard, Steel, Manual Round Volume Dampers:

   1. Manufacturers:
      a. Nailor Industries Inc.
      b. Pottorf; a division of PCI Industries, Inc.
      c. Ruskin Company.

   2. Ratings:
      a. Temperature Ratings: -25° to 180°F
      b. Maximum Velocity: 1500 fpm
      c. Differential Pressure Ratings: 1 in. wg

   3. Construction:
      a. Frame: 6” x 22 gauge galvanized steel.
      b. Blades: 22 gauge galvanized steel – single round center – V.
      d. Control Shaft: 3/8” x 3” square drive with manual locking quadrant.
      e. Bearings: Synthetic.
      g. Mounting: Vertical or horizontal
      h. Actuator: Hand quadrant for 3/8” (10) square extended shaft.

2.5 Combination Fire And Smoke Dampers

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

   2. Pottorf.
   3. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Resistance Rating: 1-1/2 hour or 3 hour.

E. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel, with mechanically attached corners.
F.  Heat-Responsive Device: Resettable, 165 deg F rated, fire-closure device.

G.  Smoke Detector: Not required for this project since “full or all area smoke coverage” system shall be utilized to activate combination fire smoke damper.

H.  Blades: Airfoil blades, horizontal, interlocking, 0.063-inch thick, galvanized sheet steel.

I.  Leakage: Class II for 1-1/2 hour fire resistance rating or Class I for 3-hour fire resistance rating.

J.  Rated pressure and velocity to exceed design airflow conditions.

K.  Mounting Sleeve: Factory-installed, 0.039-inch thick, galvanized sheet steel; length to suit wall application with factory-furnished silicone calking.

L.  Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1.  Motor Sizes: Size large enough so driven load will not require motor to operate in service factor range above 1.0.

2.  Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Controls for HVAC."

3.  Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

4.  Electrical Connection: 115 V, single phase, 60 Hz.

M.  Accessories:

1.  Test and reset switches, damper mounted.

2.6  Flange Connectors

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

1.  Ductmate Industries Inc.
2.  Ward Industries Inc.

B.  Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C.  Material: Galvanized steel.

D.  Gage and Shape: Match connecting ductwork.

2.7  Turning Vanes

A.  Manufacturers:

1.  Ductmate Industries, Inc.
2.  Duro Dyne Inc.
B. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.

C. Manufactured Turning Vanes for Metal Ducts: Turning vanes shall be an engineered airfoil design; with smoothly-rounded entry nose with extended trailing edge for low pressure drop, anti-dirt and positive fastening. Vanes shall be No. 26 hot dipped galvanized steel.

D. Rail support system shall be No. 24 hot dipped galvanized steel with pre-punched fastener holes. Tabbed or slotted dimple fasteners are not acceptable. Two fasteners shall fasten each vane to rail allowing for final vane angle angle-of-attack adjustment during installation.

E. Pressure drop performance shall be ETL tested not to exceed 0.027 in w.c. at 1,000 FPM. Generated sound power level shall not exceed 54 decibels in band 4 at 2,000 FPM-duct size 24 x 24.

F. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

G. Vane Construction: Double wall with extended trailing edge.

H. Vane Material: No. 26 gauge hot-dipped galvanized steel.

2.8 Flexible Connectors

A. Manufacturers:
   1. Casco SilentFlex II
   2. Ductmate Industries, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives:
   1. Comply with UL 181, Class 1.
   2. Fire Hazard Classification: 25/50 or less per ASTM E84, UL 723.


E. Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.
   4. R-value: R-8.0.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
6. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.9 Duct Accessory Hardware

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - Execution

3.1 Installation

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Dampers:
   1. Install balancing dampers as far back from diffusers and grilles as possible to reduce damper generated noise. This includes conditions where low pressure distribution ductwork to accompanying diffuser and grilles is completely rigid.
   2. Locate volume dampers on rigid portion of low pressure ductwork distribution and provide with locking mechanisms.
   3. Locate volume dampers to be readily accessible to TAB contractors and operation and maintenance personnel.
   4. Contractor shall properly tag all volume dampers concealed within plenum space or other architectural system in which these items are concealed. Refer to Section 230553 “Identification for HVAC”.
   5. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Flexible Ducts:
   1. Provide flexible connectors to connect ducts to equipment.
2. Flexible duct is allowed only at connections to supply diffusers and grilles.
3. Provide the appropriate radius and/or plenum accessories for proper top or side connections to air outlets or inlets to avoid pinching the flexible duct.
4. Install and support the flexible ducting in a way so as to not compromise the free open area.
5. Maximum length of flexible duct shall be limited to 6 feet.

H. Install duct test holes where required for testing and balancing purposes.
I. Install silencer according to manufacturer’s written installation instructions.
J. Provide access doors as noted below:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Location</th>
<th>Minimum Size Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control devices requiring inspection</td>
<td>Upstream or Downstream</td>
<td>18x18</td>
</tr>
<tr>
<td>Backdraft damper</td>
<td>Upstream or Downstream: Ensure visibility of damper</td>
<td>18x18</td>
</tr>
<tr>
<td>Inline fans</td>
<td>Inlet and Outlet</td>
<td>18x18</td>
</tr>
<tr>
<td>Combination fire and smoke dampers</td>
<td>Upstream or Downstream: Ensure visibility of damper</td>
<td>18x18</td>
</tr>
<tr>
<td>Outdoor intakes and mixed air plenums</td>
<td>One location per plenum</td>
<td>18x18</td>
</tr>
<tr>
<td>Full height plenum</td>
<td>One location per plenum</td>
<td>24 W x 60 H</td>
</tr>
<tr>
<td>Manual volume dampers</td>
<td>Upstream</td>
<td>8x8</td>
</tr>
<tr>
<td>Change in direction</td>
<td>Upstream</td>
<td>8x8</td>
</tr>
<tr>
<td>Turning vanes</td>
<td>Upstream</td>
<td>8x8</td>
</tr>
<tr>
<td>Maximum 50-foot (15-m) spacing. Maximum 10 foot (3m) spacing for lined ductwork.</td>
<td>N/A</td>
<td>8x8</td>
</tr>
</tbody>
</table>

3.2 Field Quality Control

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.
4. Operate combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
5. Ensure duct silencers are installed with airflow arrows in direction of airflow.

End of Section 233300
Section 23 36 00 - Air Terminal Units

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. This section specifies pressure independent, ultra-low leakage, variable air volume box with hot water reheat coil and factory furnished bottom access door.

1.3 Performance Requirements

A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and OSHPD Edition of SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".

1. Seismic Hazard Level AA: Seismic force to weight ratio, 0.48.

1.4 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units – ultra-low leakage VAV box.
2. Liners and adhesives.
3. Sealants and gaskets.

C. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.5 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. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 Closeout Submittals

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.7 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - Products

2.1 Single-Duct Air Terminal Units

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

1. Titus, Model DESV.
2. Anemostat.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing:

1. Factory-assembled, ultra-low leakage construction, manufactured of corrosion protected steel, and fabricated with a minimum of 22-gauge metal.
2. Ultra-low leakage construction:
   a. Casing leakage shall not exceed 1% of rated airflow based on a nominal inlet velocity of 2000 fpm at 3.0" w.g. of inlet static pressure.
   b. Seal all seams with butyl tape and test damper and casing leakage at 6.0" w.g. For VAV boxes with heating hot water coils, provide hot melt sealer around tubes penetrating the casing. Provide test certificate on VAV box in visible location.
3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in Air Terminal Units
ASHRAE 62.1-2010.
6. Velocity Sensor: Multi-point, center averaging sensor at air inlet duct connection.

D. Access Door:
1. Provide insulated, hinged or permanent access section between VAV box and heating coil.
2. Access door shall be secured to VAV box with quarter turn sash latches. Sheet metal covers with screws are not acceptable.
3. Provide factory furnished, hinged, 6 in by 9 in access door at the bottom of the VAV boxes.
4. Access doors shall be air tight that includes gaskets or other acceptable solution that allows for proper sealing when panels are removed and reset during normal service.

E. Insulation:
1. Internally lined with engineered polymer foam insulation. Insulation shall be 1½ pound density, closed cell foam. The insulation shall be mechanically fastened to the unit casing.
2. Insulation R-Value shall be a minimum of 1.9.
3. Insulation shall meet NFPA-90A and UL 181 requirements along with UL723 Flame/Smoke Spread (25/50).
4. The insulation shall be covered by an interior metal liner made of 26 gauge galvanized steel. The interior metal liner shall isolate insulation from the airstream and allow for cleaning of the terminal unit interior surfaces. All wire penetrations through the interior metal liner shall be covered by grommets.

F. Volume Damper:
1. Galvanized steel with peripheral gasket and self-lubricating bearings.
2. Maximum Damper Leakage: ARI 880 rated, 1 percent of nominal airflow at 4-inch wg inlet static pressure.

G. Hydronic Coils:
1. Copper tube with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F.

H. Attenuator Section:
1. Minimum 22 gauge galvanized steel.
2. Lining:
   a. Internally lined with engineered polymer foam insulation which complies to UL181 and NFPA 90A. Insulation shall be 1½ pound density, closed cell foam. The insulation shall be mechanically fastened to the unit casing.
   b. Duct liner shall have maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   c. The insulation shall be covered by an interior metal liner made of 26 gauge galvanized steel. The interior metal liner shall isolate insulation from the airstream and allow for cleaning of the terminal unit interior surfaces. All wire penetrations through the interior metal liner shall be covered by grommets.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
I. Sound Power Level:

1. Air terminal unit sound power level shall be based on static pressure drop from the unit inlet to the unit outlet with primary damper full open shall be at 0.5 in static pressure.
2. Air terminal unit radiated noise criteria shall not exceed 23 NC and discharge noise criteria shall be 10 NC or less based on AHRI 885 Appendix E.

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units.
2. Disconnect Switch: Furnished and field installed by Division 26 contractor.

K. Control Panel Enclosure: NEMA 1 control enclosure with access panel mounted on side of air terminal unit.

L. Direct Digital Controls:

1. Control devices shall be compatible with specification section 230900 “Instrumentation and Controls for HVAC”.
2. NOCCCD’s DDC system is Johnson Controls.

M. Control Sequence:

1. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
2. Refer to specification section 230960 “Sequence of Operations”.

2.2 Hangers And Supports

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 Seismic-Restraint Devices

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped] to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 Source Quality Control

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - Execution

3.1 Examination

A. Examine VAV box before installation. Reject VAV boxes that are damaged.

3.2 Installation

A. Field Mock-Up:

1. Provide field mock-up of one fully piped VAV for review and approval by the NOCCCD Facilities and Project Engineer.
2. The goal of the field mock-up installation is to confirm conformance to NOCCCD standards, which will be used as template for all air terminal units.

B. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

C. Protect interior of air terminal units from moisture, construction debris and dust, and other foreign materials.

D. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

E. Install wall-mounted room temperature sensor.

F. Access Doors:

1. Provide an access door upstream of the coil and downstream of the damper. Access doors shall be 6 in by 9 in at the bottom of the VAV boxes.
2. Provide access door with means of easy removal and replacement, including an acceptable form of latching which does not require tools to open and close.
3. Where factory fabricated, provide access doors designed/constructed to be air tight, including gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service.

3.3 Hanger And Support Installation
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   2. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 Seismic-Restraint-Device Installation

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with OSHPD Edition of SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." with seismic hazard level AA.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

E. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.

3.5 Connections

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."
D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.6 Identification

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC" for equipment labels and warning signs and labels.

3.7 Field Quality Control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 Startup Service

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.9 Demonstration

A. Train the NOCCCD's maintenance personnel to adjust, operate, and maintain air terminal units.

End of Section 23 36 00
Section 23 37 13 - Diffusers and Grilles

PART 1 - General

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

1.2 Summary
   A. Section includes diffusers and grilles.

1.3 Action Submittals
   A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
      1. “No Exception Taken”.
      2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

   B. Product Data: For each type of product indicated, include the following:
      1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
      2. Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
      3. Provide sound or NC ratings for each diffuser and grille.
         a. Labs and office space NC level from air distribution shall not exceed NC-30.
         b. Conference rooms, meeting rooms and huddle rooms NC level from air distribution shall not exceed NC-25.

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. 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.
PART 2 - Products

2.1 Modular Core Diffusers, CD-1, CD-2:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Titus, Model MCD.
   2. Anemostat.

B. The diffuser backpan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule. The diffuser neck shall have at least a 1-inch depth for easy duct connection. Diffuser shall be provided with square inlet integral to the frame assembly and with a transition piece to facilitate attachment to round duct.

C. The diffuser core shall consist of fixed louver directional modules, which can be easily repositioned without tools in the field for one-, two-, three- or four-way discharge. Each module shall be easily removable.

D. The finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

E. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

F. The manufacturer shall provide published performance data for the modular core diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006.

2.2 Adjustable Round Diffuser, CD-3:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Titus, Model TMRA.
   2. Anemostat.

B. Round ceiling diffusers shall have four cones and round neck inlets of the sizes and mounting types shown on the plans and outlet schedule. Round diffusers shall be constructed of 18-gauge steel. The airflow discharge pattern shall be field adjustable from horizontal to vertical by extending or retracting the inner three cones. These three cones shall be constructed as a single inner assembly and must be easily removable using a spring lock mechanism. Vertical to horizontal discharge pattern must be achieved by one of three adjustment methods as follows:
1. Type 1. The inner cone assembly can be removed and repositioned by means of adjusting screws.
2. Type 2. The inner cone assembly can be adjusted by sliding the cones up or down.
3. Type 3. The center cone can be rotated clockwise or counterclockwise to move the cones up or down.

C. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

D. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. The manufacturer shall provide published performance data for the round diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006.

2.3 Return Grille, RG-1:

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

1. Titus, Model PXP
2. Anemostat.

B. Perforated face panels shall have 3/16-inch diameter holes on ¼-inch staggered centers and no less than 51 percent free area. The return panels shall be provided in the sizes and mounting type shown on the plans and outlet schedule.

C. The finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

D. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. The manufacturer shall provide published performance data for the perforated return panels. The panels shall be tested in accordance with ANSI/ASHRAE Standard 70-2006.

2.4 Return Grille, RG-2:

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

1. Titus, Model 350RL.
2. Anemostat.

B. Steel return grilles shall have ⅜-inch blade spacing of the sizes and mounting types shown on the plans and outlet schedule. The fixed deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 1½-inch wide border on all sides. Screw holes shall be
countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

C. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.

D. The grille finish shall be white. The finish shall be an anodic acrylic paint, baked at 315° F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film.

E. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

F. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.5 Supply Grille, SG-1:

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

1. Titus, Model 300RL.
2. Anemostat.

B. Steel supply grilles shall be double deflection of the sizes and mounting types shown on the plans and outlet schedule. The deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 1¼-inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

C. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on ¾-inch centers. Blades shall have steel friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable.

D. The grille finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-2006.

2.6 Exhaust Grille, EG-1:

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

1. Titus, Model 350RL.
2. Anemostat.

B. Steel return grilles shall have ¾-inch blade spacing of the sizes and mounting types shown on the plans and outlet schedule. The fixed deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 1¼-inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

C. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.

D. The grille finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

PART 3 - Execution

3.1 Examination

A. Examine all diffusers and grilles before installation. Reject any diffuser or grille that are damaged.

B. Examine areas where grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 Installation

A. Install grilles level and plumb.

B. Install grilles with airtight connections to ducts and to allow service and maintenance of dampers.

3.3 Adjusting

A. After installation, adjust grilles to air patterns indicated, or as directed, before starting air balancing.

End of Section 233713
Section 23 82 19 - Fan Coil Units

PART 1 - General

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

1.2 Summary
   A. This section specifies fan coil units and accessories.

1.3 Action Submittals
   A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
      1. “No Exception Taken”.
      2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
   B. Product Data: For each type of product.
      1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   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.

1.4 Closeout Submittals
   A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
      1. 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 one set of spare MERV 8 filters for each filter installed.
2. Fan Belts: Furnish one set of 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.

PART 2 - Products

2.1 Fan Coil Units

A. Manufacturer shall be Data Aire or equal (no known equal).

B. Provide and install an indoor, air conditioning system designed specifically for use in small telecom rooms capable of cooling and filtering air. The unit shall be mounted in the ceiling space exposed to view.

C. Units shall be ETL or UL listed.

D. The frame shall be constructed of 14 gauge welded tubular steel and be coated with a heavy corrosion inhibiting finish for long life. The side panels shall be of galvanized steel. The cabinet shall be insulated with one-half inch (1/2") thick, closed cell insulation. The plenum shall be of cold rolled steel and painted in a cloud white finish. The plenum shall be field mounted. The unit shall be serviceable through the removable side panels. The vertical air flow units are to be ceiling mounted, exposed to view. The horizontal supply/return air unit is to be ceiling hung with duct work attached to supply and return openings. The total cooling capacity shall be 17,900 BTU/h @ 72 degree F DB and 60 degree F WB entering air temperature. The voltage shall be 208, 1 phase, 60 hertz.

E. Electrical - All electrical components including contactors, relays, control transformers, and capacitors shall be pre-wired. The control circuit voltage shall be 24 volts. A micro-switch shall disable the unit operation prior to condensate pan overflow should the drain line become plugged with debris.

F. Provide two inch, 60% efficient (based on ASHRAE Std. 52-76) disposable filter of twenty inches square (20" x 20"). The filter shall be located behind and accessible through the hinged return air grille.

G. Water cooled self-contained refrigeration system shall be self-contained, factory assembled, charged and
tested. No refrigerant piping connections shall be required. The unit shall contain an evaporator and condenser section.

H. The evaporator section shall have a cooling coil constructed with copper tubes and aluminum fins. The single refrigeration circuit shall include the expansion valve with external equalizer, filter drier, and high and low pressure safety switches. The scroll type compressor shall have internal overload protection. Units with capillary tube metering devices shall not be acceptable. The compressor shall have a sound attenuation blanket factory installed for sound attenuation. The evaporator blower assembly shall be draw-through configuration consisting of a double inlet, double width, centrifugal fan with belt drive, variable pitch sheave, and self-aligning ball bearings rated for an average life of 100,000 hours. The fan motor shall be 3/4 horsepower. Air delivery shall be a minimum of 550 cfm. The condensate drain pan shall be constructed of stainless steel and provide a positive drain to prevent standing water in the condensate pan.

I. A high efficiency coaxial water cooled condenser with head pressure activated 2-way water regulating valve with manual bypass gate valve built into the refrigeration system shall be provided. The capillary tube connection from the water regulating valve to the refrigerant system shall be connected with a Schrader fitting that allows replacement without affecting the refrigerant charge, making recovery unnecessary. Maximum operating water pressure shall be 150 psi.

J. Data Alarm Mini Processor - The control system shall be furnished with the microprocessor based Data Alarm Mini Processor. The panel shall include unit switching functions and display normal functions, malfunctions, and service diagnostics on a one row, 16 character liquid crystal display (LCD) in clear vernacular format. The panel shall automatically display temperature and humidity along with all operational and alarm messages. The panel shall recall and display the high and low temperature and the high and low humidity for the last 24 hours, current percent of capacity and average percent of capacity for the last hour of operation for compressor, reheat, humidification and dehumidification.

K. Programming shall have a 2-level password security to prevent unauthorized access. Programming shall be accomplished entirely from the microprocessor. Programmable functions shall be entered on non-volatile EEPROM to insure program retention should power fail. Multiple messages shall be displayed by automatically scrolling from each message to the next. Alarm conditions, in addition to being displayed, shall enunciate an audible alarm with variable output. Additional test or service terminals shall not be required for any functions.

L. An alarm condition shall continue to be displayed until the malfunction is corrected. Multiple alarms shall be displayed sequentially in order of occurrence and only those alarms which have not been acknowledged shall continue to sound an audible alarm. The Data Alarm Mini Processor shall perform an automatic self-test on system start-up. A user accessible diagnostic program shall aid in system component trouble shooting by displaying on the unit LCD screen output relay number, terminal plug and pin number for each controlled item.

M. The following functions shall be programmable:

1. Temperature Setpoint (65-80° F, 18.3-26.7° C)
2. Temperature Sensitivity (1-5° F, C in 0.1 increments)
3. Humidity Setpoint (30-70% RH)
4. Humidity Sensitivity (1-10% RH in 0.1 increments)
5. Temperature Alarm Points
6. Humidity Alarm Points
7. Unit Start Time Delay
8. Interstage Time Delay
9. Password 1st Level
10. Password 2nd Level
11. Audio Alarm Level
12. Restart Mode
13. Firestat Trip Temperature
14. Local Alarm Function

N. The following normal functions shall be monitored and displayed:

1. Current Temperature (deg F/C)
2. Current Humidity (% RH)
3. Cooling
4. Reheat
5. Humidification
6. Dehumidification
7. Percent of Capacity

O. The following alarm functions shall be monitored and displayed when they occur, in addition to enunciating an audible alarm:

1. Room Over Temperature,
2. Room Under Temperature,
3. Room Over Humidity,
4. Room Under Humidity,
5. Compressor High Pressure,
6. Condensate Pan High Level,
7. Firestat Tripped,
8. Power Failure Restart,
9. Compressor Short Cycle,
10. Temperature Sensor Error,
11. Humidity Sensor Error,
12. Local Alarm

P. The following switching and control functions shall be included:

1. System On/Off Switch,
2. Menu Selection Button for: Programming Operational Information
3. Diagnostics
4. Historical Data
5. Alarm Silence/Program Set Button

PART 3 - Execution

3.1 Examination

A. Examine fan coil units before installation. Reject fan coil units that are damaged.

B. 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.

C. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 **Installation**

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 Isolation and Seismic Restraints".

D. Verify locations of temperature sensors and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches 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 condenser water piping adjacent to machine to allow service and maintenance.
2. Connect condenser water 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: Engage a qualified testing agency to perform tests and inspections.

B. 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. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.
3.5 Adjusting
   A. Adjust initial temperature set points.

3.6 Demonstration
   A. Engage a factory-authorized service representative to train NOCCCD maintenance personnel to adjust, operate, and maintain fan coil units.

End of Section 23 82 19
SECTION 26 05 00 – Common Work Results for Electrical

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
5. Common electrical installation requirements.

1.3 Commissioning

A. Management:

1. The Commissioning Agent (CA) is hired directly by the University.
2. The CA directs and coordinates the commissioning activities and the reports to the University’s Representative.
3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the University Representative.
5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

B. Commissioning requires the participation of Division 26 Electrical Contractor to work to ensure that all systems are operating in a manner consistent with the Design Intent.

1. The general commissioning requirements and coordination are detailed in Division 1, Section 019000 General Commissioning Requirements and Division 26.
2. This Division shall be familiar with all parts of Division 1 and Division 26 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. The Electrical Contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the University Representative has signed off on the commissioned systems.

1.4 Definitions

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.
1.5 **Submittals**

A. Refer to Division 01 for additional requirements.

B. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

C. Note that prior to acceptance of shop drawings for review, a submittal schedule shall be submitted to the University’s Representative.

D. Submit all Division 26 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package.

1. Individual or partial submittals are not acceptable and will be returned without review.

E. **Shop Drawings:**

1. Provide all shop drawings in latest version of AutoCAD format.
2. Drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of 1/4-inch per foot, except as specified otherwise.
3. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
4. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
5. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.

F. Whenever more than one (1) manufacturer’s product is specified, the first named product is the basis of design used in the Work and the use of alternate-named manufacturer’s products or substitutes may require modifications in that design. If such alternatives are proposed by the Contractor, there may be additional design work required. Within 15 days of the submittal of a proposed alternate, as presented in the Contractor’s submittal, the architect and engineers will provide the design fees to modify the issued drawings for the work to incorporate that alternate into the documents. The contractor shall assume all costs required to make necessary revisions and modifications to the design, including all professional fees to the Architect and Engineers for the evaluation and revisions or modifications of the documents resulting from the substitution or selection of an alternate manufacturer submitted by the Contractor.

G. All submittals must be turned in to the General Contractor and/or University within 30 days of the award to the Subcontractor. Failure to submit any or all items shall not result in a delay in the schedule or a schedule extension. If more time is required to compile a specific submittal, then a formal request in writing may be submitted, requesting more time. This request should list the item or system, the CSI Division Section, the reason for the delay, and the date when this item will be submitted. This will be reviewed by the Contractor and Architect and a response will be prepared within one week. Selection of alternates or substitutions can significantly affect the design, especially with regard to appearance, performance, and integration with other elements. All criteria must be evaluated to maintain the integrity of the design as approved by the University and the University’s Representatives.

H. **Proposed Products List:** Include Products as required by the individual section in this Division.

I. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop
drawings returned from the University’s Representative bearing the University's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the University’s Representative without additional compensation.

J. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.

K. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the University Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the University Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

L. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.

M. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

N. Product Data: For sleeve seals.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   5. Add installation shall be maintainable.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or
otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

E. Coordinate all equipment with other trades not limited to HVAC, plumbing and contractor to adjust breakers, feeders, all associated appurtenances etc if equipment procured in field differs from design documents.

PART 2 - Products

2.1 Sleeves for Raceways And Cables

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 Sleeve Seals

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, 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. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Stainless steel Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 Grout

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
PART 3 - Execution

3.1 Common Requirements For Electrical Installation

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.
F. Do not interrupt electric service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify University in writing no fewer than 21 days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without University’s written permission.

3.2 Sleeve Installation For Electrical Penetrations

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Extend sleeves installed in floors 2 inches above finished floor level.
G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 Sleeve-Seal Installation

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 Firestopping

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

End Of Section 26 05 00
SECTION 26 05 19 – Low-Voltage Electrical Conductors and Cables

PART 1 - General

1.1 Related Documents

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

B. Section 260553, "Identification for Electrical Systems."

1.2 Summary

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

1.3 Definitions

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated.

C. Qualification Data: For testing agency.

D. Field quality-control test reports.

1.5 Quality Assurance

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 2010 California Electrical Code

1.6 Coordination

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - Products

2.1 Conductors And Cables

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

1. American Insulated Wire Corp: a Leviton Company
2. General Cable Corporation.

B. Required - Single Conductors 600V and below:

1. Provide copper conductors.
2. Provide stranded or solid conductors as specified in this section.
3. Provide conductors with Type THHN/THWN, 90°C insulation for indoor applications.
4. Provide conductors with Type THWN-2 or XHHW-2, 90°C insulation for exterior, wet or damp locations.
5. Provide conductors with Type RHW-2, 90°C insulation for areas subjected to temperatures exceeding 60°C (140°F).
6. Comply with NEMA WC 70.

C. Aluminum Conductors and MC cables are not allowed.

2.2 Connectors, Splices And Terminations

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

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division
5. Tyco Electronics Corp

B. Description: Factory-fabricated connectors, splices and terminals of size, ampacity rating, material, type, and class for application and service indicated.

C. Connections to Fixtures: Make circuit wiring connections to fixture wire with insulated electrical spring connectors. Threaded-type wire nuts, porcelain or Bakelite are not acceptable.

D. Wire Joints:
1. No. 6 AWG and larger: Burndy Type QPR, Penn Union, or equal.
2. No. 8 AWG and smaller: Pigtail splices, or mad with insulated electrical spring connectors.

E. Terminations:
   1. Provide compression set, bolted, or screw type lug, or direct to bolted or screw type terminal.
   2. Connections to Circuit Breakers and Switches:
      a. No. 12 AWG wire: formed around binding post or screw.
      b. No. 10 AWG and No. 8 wire AWG: Buchanon Termend, or equal locking tongue lug.
      c. No. 6 AWG wire and larger: Burndy Qiklug Type QDA, Penn Union, or equal, round flange solderless lug.

2.3 Sleeves For Cables

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 Plastic Cable Ties

A. Nylon or approved, locking type.
B. Metallic ties are not allowed.

2.5 Sleeve Seals

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - Execution

3.1 General:

A. Do not exceed cable manufacturer’s recommendations for maximum pulling tension and minimum bending radius. Where pulling compound is used, use on UL listed compound compatible with the cable
outer jacket and with the raceway involved.

B. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

C. Where single conductors and cables in manholes, handholes, vaults, cable trays and other indicated locations are not wrapped together by some means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon self-locking releasable cable ties placed at intervals not exceeding 18 inches on center.

3.2 Conductors 600v And Below:

A. Provide conductor sizes indicated on Drawings.

B. All wiring shall be installed in conduit unless noted otherwise.

C. Install conductors only after:
   1. Building interior is enclosed and weather tight
   2. Mechanical work likely to damage conductors has been completed
   3. Raceway installation is complete and supported

D. Arrange wiring in cabinets, switchgear and electrical equipment neatly cut to proper length, remove surplus wire and bridle and secure in an acceptable manner.

E. Conceal cables in finished walls, ceilings and floors, unless noted otherwise.

F. Pull conductors into raceway at same time. Use pulling means; including fish tape, cable, rope and basket-weave wire/cable grips that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible. Protect exposed cables from damage.

H. Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

I. Identify and color-code conductors and cables according to Section 26 05 53 “Identification for Electrical Systems”.

J. Wiring at outlets: Install conductor at each outlet, with at least 12 inches of slack.

K. Limit conduit fill to a maximum of 9 current-carrying conductors. No more than three branch circuits plus associated neutral and ground conductor will be allowed.

L. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

M. Cap spare conductors and conductors not terminated with UL listed end caps.

N. For conductors that will be connected by others, provide at least 6 feet spare conductors in freestanding panels and at least 2 feet spare in other assemblies. Provide more spare conductors in any particular assembly where it is obvious that more conductors will be needed to reach the termination point.
3.3 Conductor Material Applications:

A. Branch Circuits: Copper conductors, solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

B. Minimum conductor sizes shall be as follows:

1. No. 12 AWG – branch circuits of any kind.
2. No. 14 AWG – Remote control and signal systems, fire alarm systems, except for initiating or data.

C. Branch wiring length limitations.

1. 208Y/120V circuits over 100ft in length: Increase wire size on one size for each 60 ft of length. Increase conduit size as required.
2. 480Y/277V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.

3.4 Conductor Insulations And Wiring Methods:

A. Service Entrance: Type THW-2 or XHHW-2, single conductors in raceway.

B. Feeders:

1. Less than 100A: Type THHN-THWN, single conductors in raceway.
2. 100A and Larger: Type THW or XHHW-2, single conductors in raceway.
3. Exposed, concealed in concrete, below slabs-on-grade and underground Feeders: Type THW or XHHW-2, single conductors in raceway.

C. Branch Circuits:

1. Exposed: Type THHN-THWN, single conductors in raceway.
2. Indoors: Type THHN-THWN, single conductors in raceway.
3. Concealed in Concrete, below Slabs-on-Grade and Underground: Type THWN-2, single conductors in raceway.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh and strain relief device at terminations to suit application.

E. Class 1 Control Circuits: Type THHN-THWN, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN, in raceway

3.5 Conductor Color Codings:

A. Smaller than No. 6 AWG: Provide all single conductors with integral insulation pigmentation of the designated colors.

B. No. 6 AWG and larger: Conductors may be provided with color coding by wrapping the conductor at each end and all accessible locations with vinyl tape. Wrap at least six (6) full overlapping turns of tape around the conductor covering an area of 1 ½ to 2 inches wide at a visible location.

C. Use the following colors as described:
### System | Conductor | Color
--- | --- | ---
All Systems | Equipment Grounding | Green
240/120 Volts | Grounded Neutral | White
1-Phase, 3-Wire | One Hot Leg | Black
 | Other Hot Leg | Red
208Y/120 Volts | Grounded Neutral | White
3-Phase, 4-Wire | Phase A | Black
 | Phase B | Red
 | Phase C | Blue
480Y/277 Volts | Grounded Neutral | Gray
3-Phase, 4-Wire | Phase A | Brown
 | Phase B | Orange
 | Phase C | Yellow

D. Phase Rotation: Phase A, B and C implies the direction of positive phase rotation.

#### 3.6 Connectors, Splices And Terminals:

**A. Connectors:**

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with the connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of No. 8 AWG conductors and larger. Install with hydraulic compression tool.
3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of No. 10 AWG conductors an smaller.
4. Tighten electrical connectors according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 466A-486B.

**B. Splices:**

1. Splice wires and cable only in one accessible location, such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps and splices of No. 1 AWG conductors and larger.
5. Plastic snap-on splice insulators are not allowed.
6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
7. No WAGO type splice connectors permitted.

**C. Terminals:**

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw
terminal cannot be removed.
3. Train wires to eliminate fanning of strands, crimp with proper tool and die.
4. Torque screw termination per manufacturer’s recommended values.
5. If manufacturer’s torque values are not indicated, use those specified in UL 466A-486B.

3.7 Cable Ties:

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.8 Fireproofing:

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

B. Wrap together as a single cable all conductors entering from each conduit.

C. Follow tape manufacturer’s installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape.

3.9 Field Quality Control

A. The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for service entrance and feeder conductors for compliance with requirements.

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

B. Required testing protocols:

1. The independent testing agency shall perform the following field tests and inspections and prepare test reports:
   a. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements
   b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.3. Certify compliance with test parameters.
   c. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
      1) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      2) Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      3) Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
   d. Perform insulation resistance testing of all power and control circuits below 600 volts with a 500-volt megger, applied for 1 minute.
2. Corrective measures:
   a. Remove and replace malfunctioning circuits/feeders and retest as specified above.

End of Section 26 05 19
SECTION 26 05 26 – Grounding and Bonding for Electrical Systems

PART 1 - General

1.1 Related Documents

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

B. Section 260553, "Identification for Electrical Systems."

1.2 Summary

A. Section Includes: Grounding systems and equipment.

B. Section includes grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.

1.3 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each type of product indicated.

C. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Ground rings.

D. Qualification Data: For qualified testing agency and testing agency's field supervisor.

E. Field quality-control reports.

F. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Instructions for periodic testing and inspection of grounding features at test wells, and ground rings based on NETA and NFPA 70B standards.
      a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
b. Include recommended testing intervals.

1.4 Quality Assurance

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - Products

2.1 General

A. The entire electrical installation consisting of non-current carrying metal parts (i.e. raceways, cable trays, boards, boxes, cabinets, fixtures, switches, transformers, equipment and etc.) shall be completely and effectively grounded in accordance with all applicable codes and standards, whether or not such connections are specifically shown or specified.

B. Grounding electrodes: The grounding electrodes provided shall be as stated in CEC, except minimum conductor size used shall be #4/0 AWG and the minimum length of cables buried for grounding purposes shall be doubled.

C. The resistance values for the electrical system shall be as follows:
   1. Resistance from the main switchboard ground bus through the ground electrode to earth shall not exceed 5 OHMS unless otherwise noted.
   2. Resistance from the farthest panelboard, switchboard and etc. ground bus through the ground electrode to earth shall not exceed 20 OHMS unless otherwise noted.

2.2 Conductors

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. All grounding products/materials shall be UL labeled and conform to the requirements of CEC and IEEE standards.

C. Bare Copper Conductors:
   4. Sizes and types of conductors in four subparagraphs below are typical examples. 28-kcmil bonding cable in first subparagraph is slightly larger than No. 6 AWG.
   5. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   6. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   7. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   8. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
D. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.3 Ground Rods:

A. Manufacturers:

1. Eritech / Erico
2. Blackburn / Thomas & Betts
3. Galvan Industries

B. Characteristics:

1. All ground rods shall be copper clad steel with heavy uniform copper coating, 10’ long and minimum of 3/4” in diameter.

2.4 Ground Bars:

A. Manufacturers:

1. Eritech / Erico
2. Copperweld
3. Harger

B. Characteristics:

1. Provide rectangular annealed copper ground bars with pre-punched holes. The spacing and size of ground bar holes shall match the connection holes required for terminal lugs being furnished.
2. Provide mounting kit complete with fasteners, insulators and brackets as required.
3. Dimensions: Min. 1/4” Thick x 4” Wide x 24”Long or longer as required.

2.5 Active Electrodes:

A. Manufacturers:

1. Lyncole
2. Eritech / Erico

B. Characteristics:

1. Active electrodes shall be provided as directed by FMS (Facilities Management Services) for projects that have specific/stringent grounding requirements.
3. Dimensions: 10’ long, straight.

2.6 Mechanical Connectors:

A. Manufacturers:

1. Burndy / FCI
2. Blackburn / Thomas & Betts
B. Characteristics:

1. Provide copper alloy connectors, suitable for grounding and bonding applications, in configurations required for particular installation.
2. Ground Rod Clamps: Where required, grounding conductors shall be connected to ground rods or posts using U-bolt clamps. The cable connectors shall be “GAR” (for single cable) and “GD” (for two cable) series by Burndy.
3. Water Pipe Clamps: Where required, grounding conductors shall be connected to water pipe using type “GAR-BU” series by Burndy.

2.7 Compression Connectors:

A. Manufacturers:

1. Burndy / FCI
2. Blackburn / Thomas & Betts

B. Characteristics:

1. Provide irreversible compression copper connectors with high mechanical strength and electrical integrity.
2. Terminal Lugs: Provide heavy-duty terminal lugs with inspection probe hole, extended barrel and two-hole tang for cable to ground bar terminations. The lugs shall be pre-filled with oxide inhibitor and individually sealed to prevent from moisture and contaminates prior to connection to bus bars. The lugs shall be “Hyground” series, type “YGHA” manufactured by Burndy.
3. Cable to Cable connectors: Provide high strength connectors for cable to cable and cable to ground grid connections. The connectors shall be “Hyground” series products manufactured by Burndy.

2.8 Exothermic Connectors:

A. Manufacturers:

1. Cadweld / Erico
2. Fuseweld / Thomas & Betts

B. Characteristics:

1. Provide all exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components as required.

2.9 Grounding Wells:

A. Manufacturers:

1. Jensen, catalog #N9
2. Quickset, catalog # EC-17

B. Component Characteristics:

1. Ground wells shall be precast concrete boxes equipped with cast iron covers with a cast iron frame cast into the box. The covers shall be checkered and bolt-on type.
2. Exterior Dimensions: 14" Wide x 19" Long x 12" deep, or larger, if necessary to obtain the required clearances for accessing the connectors.
PART 3 - Execution

3.1 General:

   A. The grounding and bonding systems installation shall be in accordance with CEC, IEEE 142 and 1100.

   B. Provide wall mounted ground bars in all electrical rooms with insulated standoffs.

   C. Provide ground rods at locations indicated on Drawings and as required. Provide additional rods as required to achieve specified resistance to ground. Provide grounding well at each rod location.

   D. Grounding wells installed outdoors shall be located in the nearest usable planting area, where not otherwise indicated on the Drawings. The wells in planting areas shall be installed 2” above soil. Wells installed in non-planter areas shall be flush with the finished grade.

   E. Apply corrosion-resistant finish to all grounding and bonding products installed outdoors, damp locations and below ground, where factory applied protective coating has been damaged.

   F. Conduit terminating in concentric, eccentric or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.

   G. All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

   H. The System grounding conductors shall be insulated and a minimum of #4/0 AWG unless otherwise indicated and shall be continuous without joints or splices.

   I. Equipment Grounding Conductor:

      1. The grounding electrode/equipment conductors’ sizes shall meet or exceed CEC Tables.

      2. A separate insulated conductor (green) shall be provided within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

      3. A grounding conductor shall be extended from grounding bus of serving switchboard or panel to ground bus of downstream panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment/devices.

      4. A grounding conductor shall be provided in each flexible conduit and connected at each end via grounding bushing.

      5. Bare conductors shall be used where encased in concrete, in plenums, in direct contact with earth for ground rod rings.

   J. Isolated Grounding Conductor:

      1. A dedicated and isolated grounding conductor shall be provided for circuits supplying equipment (i.e. MRI, electronic equipment, computers and etc.) that are susceptible to Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).

      2. A dedicated and isolated ground bus shall be provided for all distribution equipment serving equipment/devices with isolated ground requirements.

      3. All isolated ground conductors for 120/208V distribution system shall be originating from upstream transformer grounding point (bus/lug).

      4. All branch circuits serving isolated ground receptacles shall include an isolated grounding conductor independent of equipment grounding conductor, which is extended from IG bus of serving panel to IG terminals of receptacle.

      5. Isolated ground conductors shall be insulated, green with yellow strip.
K. All non-electrical systems shall be bonded to grounding system, including but not limited to the following:

1. Bond all metal siding not attached to grounded structure.
2. Bond all reinforcing steel and metal accessories in any water feature (i.e. pool, fountain and etc.) structures, where applicable.
3. Bond metal HVAC air ducts to equipment grounding conductors of associated fans, motors & heaters. Provide tinned bonding jumper across flexible duct connections to maintain ground continuity.
4. Bond gas piping system for the above ground portion of the run and downstream from equipment shutoff valve.
5. Provide bonding jumpers across expansion and deflection couplings in conduit runs, piping, pipe connections to water meters and dielectric couplings in metallic cold water piping system.
6. Bond to lightning protection system, where applicable.
7. Bonding pigtails shall be insulated copper conductor, identified green, sized per code and provided with termination screw or lug.

L. Grounding Connectors and Connections:

1. Provide mechanical connections for all connections to ground rods, posts, cable trays, conduits and water pipes.
2. Provide compression connectors for cable-to-bar and cable-to-cable connections unless otherwise noted. All connections shall be torqued per manufacturer’s specification. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer and Belleville washer.
3. Provide exothermic welds for buried or concealed joints, cable-to-cable and cable to structural steel surfaces. Connections made outdoors shall be suitable for exposure to the elements. Connections made indoors shall use low smoke, low emissions process. All materials involved shall be from the same source to insure compatibility. Connections made with this process shall meet requirements of IEEE Standard 837 and other applicable specifications.
4. All Buried or concealed joints shall be inspected and approved by the inspector and the University’s Representative before concealment.

M. Power system grounding:

1. Provide, unless otherwise indicated, a main building reference ground bus at location in main electrical room that consists of the main building neutral bus bonded to the main building ground bus. Connect the following items using CEC sized copper grounding conductors to lugs on the main building neutral bus:
   a. Grounding electrode conductor from driven ground rods, concrete encased electrode and supplementary grounding electrodes.
   b. Bonding conductor to metallic cold water piping system.
   c. Bonding conductor to building structural steel.
2. Provide a dedicated ground bus in each electrical room connected to main building reference ground bus via 1”C with 1#4/0 AWG or as indicated on grounding riser diagram.

N. Separately derived electrical system grounding:

1. Ground each separately derived system per requirements in CEC as a minimum, unless greater requirements are stated elsewhere in the contract documents.
2. Transformers: Provide a dual rated four or six-barrel grounding lug with a 5/8”, 11 threaded hole. Drill enclosure with 11/16” bit and attach lug to enclosure utilizing a torque bolt and a dragon tooth transition washer or equal. Connect the following when present:
a. Grounding electrode conductor.
b. Primary feeder ground.
c. Secondary feeder ground.
d. Main bond jumper.
e. Isolated ground conductor (where applicable).

O. Telecommunication system grounding:
   1. Provide telecommunication ground bus, sized as required, wall mounted at main and each satellite telecommunication room with insulated standoffs.
   2. Provide one #4/0 AWG in 1" conduit from the Main Telecommunication ground bus to the main building reference ground bus, unless otherwise shown.
   3. Provide one #2 AWG in 3/4" conduit, unless otherwise shown from each Satellite Telecommunication ground bus or backboard to main telecommunication ground bus in the Main Telecommunication room.

3.2 Labeling
   A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
   B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
      1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.3 Field Quality Control
   A. The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations and protective devices.
   B. Perform tests and inspections.
      1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   C. Required testing protocols:
      1. General Testing:
         a. Visual and mechanical inspection:
            1) The testing agency shall inspect the grounding electrode and connections prior to concrete encasement, burial, or concealment.
            2) Check tightness and welds of all ground conductor terminations.
            3) Verify installation complies with the intent of the contract documents
         b. Electrical Tests: The resistance to ground for all systems shall be measured by the "direct" method or "fall-of-potential" method.
            1) Perform "fall-of-potential" test per Institute of Electrical and Electronic Engineers (IEEE) Standard No. 81, Section 9.04 on the main grounding electrode or system.
2) Perform the 2 point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.

3) The earth electrode under test must be far enough away from the water pipe system to be outside its sphere of influence. Rule of thumb: Distance from the earth electrode system to the water pipe system should be about 10 times the radius of the electrode or grid to obtain a measurement within an accuracy of plus or minus 10%.

c. Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth.

d. Device Testing: When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.13 as appropriate. Certify compliance with test parameters.

3. Perform ground resistance and continuity testing in accordance with IEEE 142.

4. Adjustments: Furnish and install additional bonding and add grounding electrodes as required complying with resistance limits specified under this Section of the Specification.

End of Section 26 05 26
SECTION 26 05 29 – Hangers and Supports for Electrical Systems

PART 1 - General

1.1 Summary

A. Section includes:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 Performance Requirements

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project.

1.3 Action Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
   1. “No Exception Taken”.
   2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For steel slotted support systems.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Equipment supports.

1.4 Informational Submittals

A. Welding certificates.

1.5 Quality Assurance

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

B. Comply with NFPA 70.
PART 2 - Products

2.1 Support, Anchorage, And Attachment Components

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Unistrut; Tyco International, Ltd.
      b. Allied Tube & Conduit.
      c. Cooper B-Line, Inc.; a division of Cooper Industries.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.

2.2 Fabricated Metal Equipment Support Assemblies

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - Execution

3.1 Application

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in CEC. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 Support Installation

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, Spring-tension...
5. To Light Steel: Sheet metal screws.
6. 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 meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in 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.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches 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 (20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete" and Section 033053 "Miscellaneous Cast-in-Place Concrete".
C. Anchor equipment to concrete base.
   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: Comply with requirements in Section 099000 "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

End of Section 26 05 29
SECTI0N 26 05 53 – Identification for Electrical Systems

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

B. Product Data: For each electrical identification product indicated.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

D. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

E. Contractor shall provide submittal for name plates including color and wording prior to ordering for approval.

1.4 Quality Assurance


B. Comply with 2010 CEC.


D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Furnish products listed and classified by Underwriters Laboratories, Inc or by a testing agency acceptable to Authorities Having Jurisdiction as suitable for purpose specified and indicated.

1.5 Coordination

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - Products

2.1 Markers:

A. Manufacturers:

1. Thomas & Betts
2. Brady

B. Provide identification devices in accordance with manufacturer’s written instructions and requirements of the CEC.

2.2 Tapes:

A. Manufacturers:

1. Kroy
2. Merlin

B. Provide identification devices in accordance with manufacturer’s written instructions and requirements of the CEC.

PART 3 - Execution

3.1 Installation

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated on the drawings. Provide numbering, lettering, and colors as approved in submittals and as required by Code.

B. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. Verify identity of each item before installing identification products.
C. Nameplates – General:

1. Provide laminated, engraved plastic nameplates with \( \frac{3}{8} \) inch high letters for all switchgear, switchboards, motor control centers, transfer switches, panelboards, signal system equipment cabinets, and terminal cabinets. Provide similar nameplates with \( \frac{3}{8} \) inch high letters for transformers, time switches, individually mounted breakers, switches and controls, switchboards, and motor center branch devices. Attach nameplates to gear with sheet metal screws. Adhesive mounted nameplates are not acceptable. Refer to single line diagrams and schedules for actual designations and circuit numbers that apply to this project.

2. Include nameplate schedule on shop drawing submittals.

3. Indicate on Gear Nameplates:
   a. Line 1: Equipment designation
   b. Line 2: Primary voltage, phase, number of wires. (In addition, include kVA rating of transformers, kW rating generators, Amperes for switchgear, Automatic Transfer Switches, and panelboards).
   c. Line 3: Source equipment “Fed From” (For Automatic Transfer Switch, indicate normal and emergency source equipment and for equipment fed from a transformer, indicate source with transformer in parenthesis).
   d. Line 4: (where applicable, For Automatic Transfer Switch, indicate priority number.)

Example #1: Distribution Board DBHN1
480/277V, 3P, 4W, 2000A

Example #2: ATS EAH1
480/277V, 3P, 4W, 600A
NORMAL SOURCE – DBHN1, EMERGENCY SOURCE – EDBHN1
PRIORITY 1

Example #3: PANEL LN1A
120/208V, 3P, 4W, 150A
FED FROM DBHN1 (VIA T1A)

4. Indicate equipment and/or equipment controlled and designation on component nameplates. Examples:
   a. Switchboard Breaker: CKT 3 – PANEL LN1A
   b. Motor Switch: TOILET EXHAUST FAN EC-3
   c. Submeter: KWHR SUBMETER AIR CONDITIONING
   d. Time-Switch: TSA – PARKING LIGHTS (served from Panel A)
   e. Fire Alarm Terminal Cabinet: FIRE ALARM SYSTEM 24V DC

5. Install panelboard nameplates behind panel door in public areas and on panel face in equipment rooms.

D. Nameplate Color Schedule:

1. Over 600V: Brown letters on white label.
2. 277 through 600V: Orange letters on white label.
3. 120 through 240V: Black letters on white label.
4. Devices Connected ahead of Service Mains and Substation Secondary Mains: Letter color as per switchboard voltage on Yellow label.
5. Communication or Signal Systems: White letters on black label. Identify system and voltage.
E. Stenciled Designations: Provide readily visible block letter stenciled designations for the following with ⅜ inch high minimum letters on background of contrasting colors as outlined under Nameplate Color Schedule (above). Fabricate stencils of brass and deliver to University on completion of work. Obtain receipt and include in maintenance manual.

1. Junction and pull boxes of signal and communication systems identifying system and voltage.
2. Lighting Outlet and Junction Boxes: Identify voltage and circuits contained within box.
3. 480V Outlet and Junction Boxes: 480V. Identify circuit(s).
4. Each 10 foot length of medium voltage conduit, exposed or in accessible ceiling space and associated junction and pull boxes: DANGER HIGH VOLTAGE
5. Feeder conduit runs on 25 foot centers and on both sides of wall and floor penetrations, where visible from floor and above demountable ceilings. Indicate circuit designation and number on all feeders. Indicate system on all signal and communications system conduit sized 1½ inch and larger.

F. Labels:

1. Provide label, in addition to UL label, for each switchgear, switchboard, panelboard, transfer switch, and motor control center indicating the short circuit rating of the gear as constructed and the minimum rating of devices allowable. Submit with shop drawings.
2. At all 120V outlet locations including outlets as part of furniture system as well, provide labels with panel and circuit information using a P-touch or similar label maker with minimum ½” tape. For normal power, label shall be black letters on white tape. For emergency power, label shall be white letters on red tape.
3. At all dedicated outlet locations, in addition to label as indicated in ‘b)’ above, provide the name of the device to be connected at the dedicated outlet on the label. Example “L1A-13, Freezer”
4. At all fusible devices, either individually mounted or part of gear, provide a label (as supplied by fuse manufacturer) or nameplate inside each switch cover, indicating specific type of fuse required for replacement.

G. Emergency System:

1. Identify all enclosures per Article 700 of the CEC.
2. Paint junction box covers and covers of multi-outlet assemblies red.
3. Use visibly red receptacles and devices. Alternately, engrave plates “EMERGENCY SYSTEM” and fill in with red enamel.

H. Conduit and Conductors:

1. Tag feeders at panels, switchboards, pull boxes, manholes and other accessible enclosures, indicating source, voltage, circuit number, and conductor ampere rating. Tags to be readily readable after installation.
2. Identify medium voltage conductors with phase and circuit number.
3. In exterior or wet locations, and for medium voltage conductors in all locations, provide 1½ inch diameter brass discs engraved or embossed with 3/16 inch minimum high letters and tied with No. 16 AWG galvanized wire.
4. In interior dry locations, provide metal or laminated plastic discs as above, attached with nylon cord.
5. Tag exposed ends of conduit stubs indicating system, name of panel, switchboard, etc., of origin and conduit size.
6. Identify all branch circuit system conductors with pre-marked self-adhesive, wrap around cloth wire markers, indicating circuit number and name of panel, cabinet, etc, or origin, at panelboards, motor control centers, switchboards, isolated power panels, terminal cabinets, wireways, junction boxes and at all outlet boxes containing more than one neutral wire.
7. Identification Format Example:
   a. Switchboard Feeder – DBHN1-1 480/277V 225A
   b. Transformer Subfeeder - T1A 208/120V 380A
   c. Transfer Switch Subfeeder - EAH1 480V 800A
   d. Panel Branch Circuit - LN1A-10

8. Underground Electrical Line Identification: Install line marker for underground wiring, both direct-burial and in raceway. During trench backfilling, for underground power, signal, and communication lines, install continuous underground plastic line marker, located directly above line 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, install a single line marker.
   a. Provide, above underground conduits stubbed for future use, engraved flush bronze marker anchored in 4 inch square by 12 inch deep concrete block, flush with grade, indicating system, conduit size and point of origin.

9. Paint fire alarm system J-boxes and pullboxes red and provide label: “Fire Alarm System”.

10. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inch wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 10 foot maximum intervals in straight runs. Apply the following colors:
   b. Fire Suppression Supervisory and control System: Red and Yellow
   c. Mechanical and Electrical Supervisory System: Green and White
   d. Telephone System: Green and Yellow

I. Conductor Color Coding: provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<table>
<thead>
<tr>
<th>System</th>
<th>Conductor</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Systems</td>
<td>Equipment Grounding</td>
<td>Green</td>
</tr>
<tr>
<td>240/120 Volts</td>
<td>Grounded Neutral</td>
<td>White</td>
</tr>
<tr>
<td>1-Phase, 3-Wire</td>
<td>One Hot Leg</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>Other Hot Leg</td>
<td>Red</td>
</tr>
<tr>
<td>208Y/120 Volts</td>
<td>Grounded Neutral</td>
<td>White</td>
</tr>
<tr>
<td>3-Phase, 4-Wire</td>
<td>Phase A</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Phase C</td>
<td>Blue</td>
</tr>
<tr>
<td>480Y/277 Volts</td>
<td>Grounded Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>3-Phase, 4-Wire</td>
<td>Phase A</td>
<td>Brown</td>
</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Orange</td>
</tr>
<tr>
<td></td>
<td>Phase C</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

J. The following field-applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:

1. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from
terminal points and in boxes where splices or tape are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

2. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

3. Color coded conductors of cables used in communication and signal systems and control conductors in line and low voltage control panels, motor control centers, and supervisory panels. Use white for grounded conductors and green for equipment ground, exclusively.

K. Devices: Engrave on each device plate with 3/16 inch high block letters with black enamel where noted and as follows:

1. Lock switch and switch with pilot light – device controlled.
2. Switch for fan, motor unit heater – equipment controlled.
3. Switch where lights or equipment are out of sight – identify area or equipment controlled.
4. Switches in gangs of three or more – identify areas or equipment switched.
5. Receptacles over 150V to ground and/or 30A and higher rating – voltage and ampere rating.
7. Where wording is not indicated, allow for ten letters per device and use wording as directed.
8. For switch cabinets engrave each device or provide engraved nameplate.

L. Warning Signs: Conform with the latest edition of the NEC. Provide No. 18 AWG steel, white porcelain enameled signs with 1 inch high letters to read “DANGER! – HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY!”. Post on doors or entries to all rooms or areas containing equipment rated over 600V and on front of such equipment enclosures. Provide similar signs with 1 inch high black letters in all electrical and signal rooms and closets reading “ELECTRICAL (or SIGNAL) ROOM – NO STORAGE PERMITTED”. Submit shop drawings.

M. Panel Schedules: Provide typewritten panel schedules on inside of panel doors behind clear plastic. Indicate as-built quantity and type of outlets served as well as general location of outlets or fixtures and/or item of equipment served. Electronic copies of all panel schedules shall be provided as part of close out documentation. Electronic panel schedules may be provided in Microsoft Excel or AutoCAD formats only. Scanned or other non-editable electronic files are not acceptable.

N. Diagrams and Posted Signs:

1. For switchboards with bus rating 1000A or greater, and for substations, provide a bus diagram framed and mounted behind clear plastic indicating bus configuration and rating, devices, ground fault detectors, standby generator connection, and switchboard components. Submit diagram for review with shop drawings.
2. For signal and communication systems, provide block wiring and location diagram mounted behind clear plastic and posted at system control location or as directed. Submit diagram for review with shop drawings.
3. For medium voltage switchgear, provide a single line bus diagram air brush painted in contrasting color across the front face of the switchgear indicating all components within cubicles including lightning arresters, metering, etc.
4. For all main electrical rooms, and/or as directed by University, provide a single line diagram framed and mounted behind clear plastic indicating as-built system configuration and distribution.

End of Section 26 05 53
SECTION 26 09 26 – Lighting Controls

PART 1 - General

1.1 Summary

A. Section Includes:

1. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), manual lighting and Mechanical VAV box control.
2. The system shall be capable of tuning lighting loads. (if lighting load is capable of being dimmed)
3. All system devices shall be networked together enabling digital communication and shall be individually addressable.
4. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.
5. The system architecture shall facilitate remote operation via a computer connection.
6. The system shall not require any centrally hardwired switching equipment.

1.2 Definitions

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 Submittals

A. The manufacturer, contractor or supplier shall resubmit this specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirements of this section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exceptions”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
3. Product Datasheets (general device descriptions, dimensions, wiring details, nomenclature)
4. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)
5. Other Diagrams – as needed for special operation or interaction with other system(s)
6. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up
7. Hardware and Software Operation Manuals
8. Other operational descriptions as needed

B. Product Data: For each type of product.

C. Shop Drawings: For lighting control panelboard outdoor fixtures and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

1.4 Informational Submittals

A. Seismic Qualification Certificates: For panelboard, accessories, and components, from manufacturer.

B. Field quality-control reports.
C. Sample Warranty: For manufacturer's special warranty.

1.5 Closeout Submittals

A. Operation and maintenance data.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Printout of software application and graphic screens.
   4. Device address list.

1.6 Quality Assurance

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
   2. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.7 Coordination

A. Coordinate lighting control and VAV box components to form an integrated interconnection of compatible components.

B. Coordinate lighting controls with BAS (if necessary) either through IP based intercommunication of system or hardwired auxiliary relay outputs.

C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.8 Warranty

A. Special Warranty: Manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

B. All devices in lighting control system shall have a 5 year warranty.

PART 2 - Products

2.1 Manufacturers

A. nLight from Sensor Switch.

2.2 System Requirements

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section).

D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.

N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.

O. WiFi-enabled devices shall be capable of current monitoring.

P. WiFi-enabled devices shall utilize WPA2 AES encryption.

Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks.

R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi-enabled system devices.

S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy,
photocell, and switch functionality for more advanced configurations and sequences of operation.

U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.

V. System shall be capable of operating a lighting control zone and VAV boxes according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

1. **Auto-On / Auto-Off (via occupancy sensors)**
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zones with occupancy sensors automatically controls VAV boxes when occupant is detected.
   c. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   d. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.

2. **Manual-On / Auto-Off (also called Semi-Automatic)**
   a. Pushing a switch will turn lights on.
   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

3. **Manual-On to Auto-On/Auto-Off**
   a. Pushing a switch will turn lights on.
   b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
   c. Sequence can be reset via scheduled (ex. daily each morning) events

4. **Auto-to-Override On**
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
   c. Sequence can be reset via scheduled (ex. daily each morning) events

5. **Manual-to-Override On**
   a. Pushing a switch will turn lights on.
   b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
   c. Sequence can be reset via scheduled (ex. daily each morning) events

6. **Auto On / Predictive Off**
   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   c. If switch is pressed, lights turn off and a short “exit timer” begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is
detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.

7. Multi-Level Operation (multiple lighting levels per manual button press)
   a. Operating mode designed specifically for bi-level applications
   b. Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
   c. Eliminates user confusion as to which of two buttons controls which load
   d. Three different transition sequences are available in order to comply with energy codes or user preference
   e. Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
   f. Depending on the sequence selected, every button push steps through relays states according to below table
   g. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.

8. A taskbar style desktop application shall be available for personal lighting control.
9. An application that runs on “smart” handheld devices (such as an Apple® iPhone®) shall be available for personal lighting control.
10. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.
11. Control software shall enable integration with a BMS via BACnet IP.

W. System shall provide the option of having pre-terminated plenum rated CAT-5 Cabling supplied with hardware.

2.3 Individual Device Specifications

A. Control Module (Gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software.
9. Device shall be capable of using a dedicated or DHCP assigned IP address.
10. Network Control Gateway device shall be the following Sensor Switch model Series:

   nGWY2

B. Networked System Occupancy Sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.

5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

6. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.

8. Sensors shall be available in multiple lens options which are customized for specific applications.

9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue.

12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.

15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

17. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)

19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.

20. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:

   - nWSD or nWSX (PIR, 1 Relay)
   - nWSD PDT or nWSX PDT (Dual Tech, 1 Relay)
   - nWSD NL (PIR w/ Night Light, 1 Relay)
   - nWSD PDT NL (Dual Tech w/ Night Light, 1 Relay)
   - nWSX NL LV (PIR w/ Night Light, No Relay)
   - nWSD PDT NL LV (Dual Tech w/ Night Light, No Relay)
   - nWSD LV or nWSX LV (PIR, No Relay, Raise/Lower Dim Ctrl)
21. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
22. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
23. Embedded sensors shall have an optional photocell
24. Embedded sensors shall be the following Sensor Switch model number:

- **nES 7 (PIR, No Relay)**
- **nES 7 ADCX (PIR w/ Photocell, No Relay)**
- **nES PDT 7 (Dual Technology, No Relay)**
- **nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)**

25. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
26. Fixture mount sensors shall be capable of powering themselves via a line power feed.
27. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
28. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
29. Sensors shall be the following Sensor Switch model numbers, with device options as specified:

<table>
<thead>
<tr>
<th>Model # Series</th>
<th>Occupancy Poles</th>
<th># of Relays</th>
<th>Lens Type</th>
<th>Detection Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>nCM(B) 9</td>
<td>1</td>
<td>-</td>
<td>Standard</td>
<td>PIR</td>
</tr>
<tr>
<td>nCM(B) 9 2P</td>
<td>2</td>
<td>-</td>
<td>Standard</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 9</td>
<td>1</td>
<td>1</td>
<td>Standard</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 9 2P</td>
<td>2</td>
<td>2</td>
<td>Standard</td>
<td>PIR</td>
</tr>
<tr>
<td>nCM(B) PDT 9</td>
<td>1</td>
<td>-</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 9 2P</td>
<td>2</td>
<td>-</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 9 2P</td>
<td>1</td>
<td>1</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 9 2P</td>
<td>2</td>
<td>2</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 9 2P</td>
<td>1</td>
<td>1</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 10</td>
<td>1</td>
<td>-</td>
<td>Standard</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 10 2P</td>
<td>2</td>
<td>-</td>
<td>Extended</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 10 2P</td>
<td>1</td>
<td>1</td>
<td>Extended</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 10 2P</td>
<td>2</td>
<td>2</td>
<td>Extended</td>
<td>Dual</td>
</tr>
<tr>
<td>nCMR(B) PDT 10 2P</td>
<td>2</td>
<td>2</td>
<td>Extended</td>
<td>Dual</td>
</tr>
<tr>
<td>nHW13</td>
<td>1</td>
<td>-</td>
<td>Hallway</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 6</td>
<td>1</td>
<td>1</td>
<td>High Bay</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 6</td>
<td>1</td>
<td>1</td>
<td>High Bay</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 6 2P</td>
<td>2</td>
<td>2</td>
<td>High Bay</td>
<td>PIR</td>
</tr>
<tr>
<td>nCMR(B) 6 480</td>
<td>1</td>
<td>2</td>
<td>High Bay</td>
<td>PIR</td>
</tr>
</tbody>
</table>

versions of the above ceiling(fixture) mount versions also shall be available (e.g. nCMR(B) 9 => nRMR 9)
30. System shall have WiFi enabled fixture mountable sensors available.
31. Embedded sensors shall have an optional photocell and 0-10 VDC dimming output
32. WiFi enable sensors shall be one of the Sensor Switch model numbers:

   nCMRB 6 WIFI (PIR, w/ Relay)
   nCMRB 10 WIFI (PIR, w/ Relay)
   nCMRB 50 WIFI (PIR, w/ Relay)
   nCMRB 9 WIFI (PIR, w/ Relay)

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor’s set-point and deadband shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the “auto set-point” setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an “offset” from the primary zone.
8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.
9. Sensor shall be the following Sensor Switch model numbers, with device options as specified:

   nCM(B) PC (on/off)
   nCM(B) ADC (dimming)
   nCM(B) PC ADC (on/off, 0-10 VDC dimming)
   nCMR(B) PC (on/off, single relay)
   nCMR(B) PC ADC (on/off, 0-10 VDC dimming, single relay)

   Note: Recessed mount versions of the above ceiling(fixture) mount versions also shall be available (e.g. nCMR(B) PC => nRMR PC)

10. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
11. Embedded sensors shall be the following Sensor Switch model number:

   nES ADCX (Dimming Photocell)

D. Networked System Power (Relay) Packs
1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.

3. All devices shall have two RJ-45 ports.

4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

7. Power Packs and Power Supplies shall be available that are WiFi enabled.

8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.

9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.

10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.

11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.

13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.

14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.

15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.

16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.

17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.

18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

19. Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:

   - **nPP16** (Power Pack w/ 16A relay)
   - **nPP16 WIFI** (Power Pack w/ 16A relay, WIFI enabled)
   - **nEPP5 D** (Power Pack w/ 5A relay and 0-10VDC dimming output)
   - **nSP16** (Secondary Pack w/ 16A relay)
   - **nSP5 2P** (Secondary Pack w/ two 5A relays)
   - **nSP5 D** (Secondary Pack w/ 5A relay and 0-10VDC dimming output)
   - **nPP16 ER** (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
   - **nSP5 D ER** (UL924 Listed Secondary Pack w/ 5A relay and 0-10VDC dimming output for switching emergency power circuits)
E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.
8. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
   - nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
   - nPANEL 2 480 (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½” knockout.
2. Devices shall have two RJ-45 ports.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output.
7. Specific I/O devices shall sense state of low voltage outdoor photocells.
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense.
10. Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:
    - nIO D (I/O device with 0-10 dimming output)
    - nIO 1S or nIO RLX (I/O device with contact closure or 0-10VDC dimming input)
    - nIO NLI (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens)

G. Networked LED Luminaires

1. Networked LED luminaire shall have a mechanically integrated control device
2. Networked LED luminaire shall have two RJ-45 ports
3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
4. Networked LED luminaire shall provide low voltage power to other networked control devices
5. System shall be able to turn on/off LED luminaire without using a relay
6. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).
8. LED Luminaires shall be the following Lithonia model families:
   
   RTLED
   TLED
   VLED
   ACLED
   AL LED
   WLED
   STLED
   MINO

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
12. Wall switches & dimmers shall be the following Sensor Switch model numbers, with device options as specified:
   
   nPOD (single on/off, capacitive touch, audible user feedback)
   nPOD 2P (dual on/off, capacitive touch, audible user feedback)
   nPODR (single on/off, one relay, capacitive touch, audible user feedback)
   nPODM (single on/off, push-buttons, LED user feedback)
   nPODM 2P (dual on/off, push-buttons, LED user feedback)
   nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
   nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
I. Networked System Graphic Wall Station
1. Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box.
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication.
7. Device shall be the following Sensor Switch model number:
   - nPOD GFX

J. Networked System Scene Controllers
1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEDs indicating current selection.
9. Scene Selector device shall be the following Sensor Switch model number:
   - nPOD 2S (2 Scene, push-button)
   - nPOD 4S (4 Scene, push-button)
   - nPOD 4S DX (4 Scene, push-button, On/Off.Raise/Lower)
   - nPOD 4L DX (4 Adjustable Presets, push-button, On/Off.Raise/Lower)

K. Communication Bridges
1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
6. Communication Bridge devices shall be the following Sensor Switch model numbers:
   - nBRG 8 (8 Ports)

2.4 Lighting Control Profiles
A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software’s host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 Management Software

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software.

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.
I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 Bms Compatibility

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7 System Energy Analysis & Reporting Software

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.8 Performance Requirements

A. Seismic Performance: Panelboard shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subpart A and Subpart B, for Class A digital devices.

2.9 Controllers

A. Description: Controllers shall contain the power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.

1. Comply with UL 916; with a microprocessor-based, solid-state, 365-day timing and control unit.

2. Power Supply: Powered from the panelboard, sized to provide control power for the operation of the remotely operated circuit breakers, controller, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.

3. Integral keypad and digital-display front panel for local setup, including the following:
   a. Blink notice, time adjustable from software.
   b. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

4. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.

2.10 Manual Switches And Plates

A. Keypads: Programmable, designed to control lighting applications and functions associated with the equipment of this Section. The units shall be able to control any system output device, including remotely operated circuit breakers, relays, dimmers, and analog outputs.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."

C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.11 Conductors And Cables

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in 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 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - Execution

3.1 Wiring Installation

A. Comply with NECA 1.
B. Wiring Method: 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.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

E. 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.

3.2 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."

3.3 Field Quality Control

A. 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 Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Acceptance Testing Preparation:

1. Test continuity of each circuit.

C. 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.

3.4 Demonstration

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

3.5 Start-Up & Support Features

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

End of Section 26 09 26
SECTION 26 27 26 – Wiring Devices

PART 1 - General

1.1  Related Documents

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

B. Section 260553, "Identification for Electrical Systems."

1.2  Summary

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Wall-box motion sensors.
4. Isolated-ground receptacles.
5. Snap switches and wall-box dimmers.
7. Wall-switch and exterior occupancy sensors.
8. Communications outlets.
10. Cord and plug sets.

1.3  Definitions

A. Retain term and abbreviations that remain after this Section has been edited.

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

F. TVSS: Transient voltage surge suppressor.

G. UTP: Unshielded twisted pair.

1.4  Submittals

A. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:

1. “No Exception Taken”.
2. “Exception”. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
B. Product Data: For each type of product indicated.

C. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 Quality Assurance

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. All devices shall conform to National Electrical Manufacturer's Association (NEMA) standards and shall be Underwriters Laboratories, Inc., (UL) listed and labeled.

E. All devices, where applicable, shall be "Specification Grade" Industrial/heavy-duty type, meeting the requirements of Federal Specification WC-596-F for receptacle and meeting the requirements of Federal Specification WS-896-E, for switches.

1.6 Extra Materials

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service Outlet Assemblies: One for every 10 but no fewer than one.

PART 2 - Products

2.1 Manufacturers

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Leviton
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2.2 Receptacles - Duplex:

A. Provide 20A, 125V AC, extra heavy-duty specification grade 2-pole, 3-wire grounding type receptacles.

B. Receptacles shall be self-grounding, back wired grounding with binding head staked terminal screws.
C. Receptacles shall have a deep treaded brass center rivet to hold cover plates without rotating or stripping.

D. The grounding contact shall be one piece brass and internally connected to the frame with ground terminal for external ground.

E. Normal receptacles shall be white and emergency receptacles shall be red.

F. Duplex Receptacles: Hubbell #HBL 5362 series or equal.

G. Duplex Receptacles: Hubbell #HBL 5361 series or equal.

2.3 Receptacles - Ground Fault Circuit Interrupting (GFCI)

A. Provide 20A, 125V AC, heavy-duty commercial grade 2-pole, 3-wire grounding GFCI receptacles.

B. The GFCI receptacles shall be in conformance with UL 943 and equipped with integral solid state sensing and signaling circuitry capable of detecting and interrupting a maximum 5 milli-amp line-to-ground fault current in approximately 0.025 second.

C. Device shall provide ground fault indicator, no power to face if reverse wired. Shall be equipped with trip indication, manual reset and test mechanisms.

D. GFCI Receptacles: Hubbell #GF20 series or equal.

2.4 Receptacles - Isolated Ground (IG)

A. Provide 20A, 125V AC, specification grade 2-pole, 3-wire grounding IG receptacles.

B. The IG receptacles shall conform to UL Standard #498, ANSI #C73 and NFPA 70 requirements.

C. IG Receptacles: Hubbell #HBL-IG 2162 series or equal.

2.5 Toggle Switches

A. Manufacturers:
   1. Hubbell - HBL series

B. Component Characteristics:
   1. Provide 20A, 120-277V AC, extra heavy-duty industrial grade toggle type switches with ground screw.
   2. The switch shall be quiet type with silver alloy contacts, abuse resistant handle, back and side wired with totally enclosed case.
   4. Three-way Switches: Hubbell #HBL-1223 series or equal.
   5. Illuminated (lighted handle w/load off): Hubbell #HBL-1221-IL series or equal.

2.6 Communications Outlets

A. Telephone Outlet:
   1. Products: Subject to compliance with requirements, provide one of the following:
2. Wiring Devices

2.6  **Wiring Devices**

   a. Cooper; 3560-6.
   b. Leviton; 40649.

2.7  **Wallplates - Metal**

   A. Manufacturers:
      1. Hubbell

   B. Provide smooth, stainless steel plates, American Iron and Steel Institute (AISI) Type 302, 0.040” thick with satin smooth finish in all areas, except as directed by University.

   C. A removable plastic film shall protect coverplates during installation. Remove film at time of final acceptance.

   D. Provide gang type coverplates where two or more devices are installed at one location.

   E. Stainless steel plates: Hubbell #S series.

2.8  **Wallplates - Nylon**

   A. Manufacturers:
      1. Hubbell

   B. Provide standard size, smooth, high-impact, non-conductive nylon plates with curved corners and captive screws in areas as directed by University.

   C. Provide gang type coverplates where two or more devices are installed at one location.

   D. Nylon plates: Hubbell #NP series.

2.9  **Wallplates – Weatherproof Covers**

   A. Manufacturers:
      1. Hubbell

   B. Provide weatherproof covers for each GFCI receptacle. Covers shall be gasketed, spring loaded, self-closing and suitable for use in damp and wet locations as described in UL 514 and CEC 406.

   C. The base plates, covers, hinge pins, spring and screws shall be all corrosion resistant die cast aluminum.

   D. Vertical position covers: Hubbell #WP26 series.

   E. Horizontal position covers: Hubbell #CWP26H series.

2.10 **Wallplates – While-In-Use Covers**

   A. Manufacturers:
1. Pass & Seymour

B. Provide weatherproof while-in-use covers for each GFCI receptacle. Covers shall be gasketed, spring loaded, vertically self-closing, suitable for use in damp and wet locations while a plug is inserted into the receptacle as described in CEC 406.8.

C. While-in-use covers: Pass & Seymour #WIUC10 series.

2.11 Finishes

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by CEC or device listing.

2. Isolated-Ground Receptacles: Orange

PART 3 - Execution

3.1 Installation

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of CEC, Article 300, without pigtails.

4. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install wiring devices in accordance with manufacturer's written instructions, as shown on the drawings and as specified herein.
11. Receptacles:
   a. Mount receptacles vertically with the centerline 18" above finished floor and with grounding slot at top.
   b. Mount GFCI receptacles above counters in bathrooms and at counters within 6'-0" of sinks, whether indicated as GFCI type or not.
12. Switches:
   a. Mount switches vertically with the centerline 42" above finished floor.
   b. Ganged switches on 277 volt circuits shall have a barrier between each switch.
   c. Provide labeling for all switches, where circuits controlled cannot be readily seen, three or more switches under a common plate.
   d. Provide wall override switches as required or indicated on plans in conjunction with ceiling or wall mounted occupancy sensors.
13. Wallplates:
   a. Covers on pressed steel outlet boxes in furred areas, attics, etc., or exposed in mechanical equipment rooms shall be of the same material as the outlet box.
   b. Provide wallplates for all outlet boxes, switches, receptacles, etc.
   c. Provide coverplates that completely cover wall opening and seat against wall.
   d. Install blank coverplates on all outlet boxes in which no device is required or installed.
   e. Refer to Section 26 05 53 “Identification for Electrical Systems” for the labels and labeling (i.e. panel and circuit number, etc.) requirements.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. California Electrical Code (CEC) sized (#12 minimum) bonding jumper shall connect grounded outlet box to receptacle grounding terminal on all flush mounted units.

G. All low voltage wiring for controls, occupancy sensors, etc., shall be in conduit.

H. Refer to Section 26 05 53 “Identification for Electrical Systems” for all device and plate color requirements.

I. All receptacle locations shall be coordinated with room furniture.

J. Do not install in ganged boxes with other devices.
3.2 Identification

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 Field Quality Control

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

End of Section 26 27 26
SECTION 26 51 00 – Lighting Fixtures Interior

PART 1 - General

1.1 Related Documents

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

B. Lighting Controls 26 09 26

1.2 Summary

A. General:

1. Section specifies requirements for luminaires, lamps, ballasts, drivers, and accessories.
2. The Contractor shall be responsible for luminaire quantities, lengths and clearances required and shall inform the Architect in writing, at the time the bid submission is made, of discrepancies or variances found with fixtures or details specified herein or in the luminaire schedule and other contract documents.

1.3 Standards

A. Codes: Luminaires, components, and installation shall be in accordance with the American National Standards Institute, the latest revision of the National Electrical Code (N.E.C.) and applicable federal, state, and local codes and regulations.

1. Lamps shall be in accordance with the Energy Policy Act of 1992 (Public Law #102-486).

B. U.L. Listing

1. Luminaires, drivers, transformers, and other electrical components shall be manufactured in strict compliance with the appropriate requirements of the Underwriter's Laboratories, Inc. and others that may be applicable such as ETL and CSA. The appropriate testing labels shall be affixed to luminaires.
2. The Contractor shall be responsible for coordinating the characteristics and the appropriate U.L. labeling of luminaires and their components with the ambient conditions which will exist when the luminaires are installed.

C. Products to be made in the USA as a standard requirement.

1.4 Submittals

A. Procedure: In accordance with Division One

B. Shop Drawings and Product Data Submittals:

1. Within fourteen days of contract award, successful Contractor shall submit a complete list of lighting products intended to be furnished with manufacturer and catalog designations, along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of specified product may adversely impact the construction schedule, it shall be brought to the attention of the owner at this time. Request for fixture substitution on the basis of delivery schedule will not be permitted.
2. Within fourteen days of bid award, the Contractor shall provide a complete list of lamps, which will be furnished on the project. This list shall be organized alphabetically by the luminaire type indicated on the luminaire schedule, and include the manufacturer and exact model number of each lamp. Up to three samples of any listed lamp shall be supplied at no additional cost to the project, if so requested by the specifier.

3. Alternate products other than those listed by name in the specification will not be considered without prior written consent from the lighting designer.

4. Submit shop drawings and product data in accordance with the requirements of the general conditions and as described herein and elsewhere in the contract documents.

5. The Contractor shall submit data for approval of the Architect, detailed shop drawings and product data for luminaires specified herein and elsewhere in the contract documents. Luminaires shall not be installed without the approval of its shop drawings, product data and/or sample.

6. Shop drawings and product data shall indicate the name of the project, fixture type, manufacturer’s name, luminaire catalog number and catalog number for lampholders, ballasts, diffusers, internal protective components and all necessary information including, but not limited to: clearances, dimensions, components, mounting hardware, materials and weights; other pertinent information, to show compliance with contract documents with regard to metal thickness and support methods.

7. Prior to fabrication and submittal of the shop drawings and product data, the Contractor shall coordinate luminaires and conduit entries with equipment, ducts, pipes, openings, etc.

8. Custom luminaire fabrication details shall be drawn at either full size or half-size scale. Fixture fabrication details shall illustrate a minimum of three critical views indicating fabrication and assembly methods, materials, and materials’ gauges and finishes, and specifications of lighting equipment and appropriate electrical, mounting and accessory hardware.

9. Where luminaires are mounted in continuous rows or in architectural coves, shop drawings shall indicate exact luminaire locations, layout, connecting components, coupling plates, changes in elevation, corner details, assembly methods, and reinforced concrete base details.

10. Submit product data which includes luminaire type, luminaire illustration with mounting details, luminaires certification of suitability for use in locations indicated, and photometric test reports which include the following:

   a. Complete candlepower summary with graphical and numerical data in 5 degree increments for up and down quadrants and at 22-1/2 degree azimuth increments including normal and parallel.
   b. Visual comfort probability data.
   c. Coefficients of utilization data.
   d. Luminaire efficiency.
   e. Lamp description.
   f. Lamp lumen output.
   g. Zonal lumens and percentages.

C. Samples

1. Upon request, submit samples of custom luminaires, modified, and substitution items for the purpose of ascertaining photometric performance, quality of visible parts and details, maintenance features, methods of installation, and safety features. These samples shall be submitted for approval at no expense to the Owner, with transportation prepaid. The samples will be returned to the Contractor after the review has been completed at the expense of the Contractor.

D. Substitutions

1. Should the Contractor elect to consider products other than those specified, the items must be submitted fourteen days in advance of the bid. Failure to submit within that deadline constitutes a
guarantee that the specified products will be supplied. The lighting designer will invoice the contractor, at senior designer hourly rates, to review any product not listed in the specification. Submittal of a bid for this project shall include a written acknowledgment of these terms from the contractor.

2. Substitutions shall be submitted in accordance with the requirements of the general conditions and as described herein and elsewhere in the contract documents.

3. The Manufacturer shall submit, upon request, a prototype sample of the substitute luminaire for evaluation of compliance with the contract documents. Shop drawings will not be acceptable in place of the prototype. A submittal for evaluation shall be an operable 120 volt non-returnable sample, complete with lamp(s), 72 inch grounded cord and plug and the specified finish.

4. The Architect will be the sole judge in determining whether the prototype sample complies with the contract documents and reserves the right to disqualify proposed manufacturer or submitted item.

5. Photometric test reports shall be submitted for each luminaire offered in substitution for a luminaire specified.

PART 2 - Products

2.1 General Luminaire Design And Construction

A. All fixtures to meet the FTC standard of, “Made in America.”

B. Manufacture luminaires to the specifications described above, hereafter, and as indicated in the luminaire schedule and contract documents. Acceptable manufactures are listed in the luminaire schedule shown on the drawings.

C. All recessed down lights must be 20 gauge cold-rolled steel housing and must be UL (IC) rated for insulated ceiling. All suspended pendants to be AA6063 T5 extruded aluminum with a minimum thickness of .078-inches so that luminaires are rigid, stable, and will resist deflection, twisting and warping under normal installation procedures, re-lamping, and maintenance.

D. Luminaire designs shall include, as applicable, plaster frames, trim rings, shrouds, flanges, backboxes, support hardware, and other components required for proper installation of the luminaire.

E. Luminaires with covers, cones, or diffuser frames, which are to be mounted above twelve feet from the finished floor level, shall be provided with safety chains or other acceptable backup means of support to properly secure such items to main housing.

F. Fixtures shall be Underwriter Laboratory approved for their application and location, or approved by an equal agency such as ETL or CSA, and have the appropriate safety listing label adhered to the fixture visible within the housing of each fixture.

G. Rows of luminaires shall be designed with concealed splice plates and shall be free of light leaks. Components such as reflectors, trims, diffusers and other visible items shall be properly aligned with no overlaps, gaps, or other imperfections.

H. Adjustable fixtures shall provide methods to lock fixture in place. This includes rotation and tilt adjusting.

I. Hardware shall be concealed where it is appropriate, unless it is a design feature.

J. Where hardware is exposed the hardware is to be painted to match adjacent surfaces unless otherwise noted.
K. Materials, accessories, and other related fixture parts shall be new and free of defects, which may impair their character, appearance, strength, ability, or function. Fixtures must be protected from damage from the time of fabrication until final acceptance of work.

L. Contractor is responsible for coordination of special mounting conditions for custom fixtures and must supply necessary mounting devices.

M. Fixtures shall be completely wired at the factory. Fixtures shall come with electrical wiring in accordance with local codes and in accordance with actual installation requirements.

N. Provide neoprene gasketing, stops, and barriers where required to prevent light leak and/or water and water vapor penetrations.

O. Provide finished product with smooth clean ground metal edges, trims, and frames as well as tight fitting connections, hinges, and closures.

P. Provide access for servicing the installed luminaire and for replacement of electrical parts without removal or disassembly of the luminaire.

Q. General downlight luminaires shall be LED. Luminaires shall be designed and constructed so that lamp seal temperatures do not exceed 350°C at an ambient of 25°C when tested in accordance with U.L. Standard #57, and shall maintain an operating bulb wall temperature of approximately 600°C and not less than 250°C.

R. Luminaire doors shall be provided as follows: Positive light seal, concealed safety hinges, and inconspicuous "positive spring loaded" holding latches, which are hingeable from either side and operable without the use of tools.

S. Where luminaires are mounted in tandem in continuous uplight or downlight coves, the Contractor shall field coordinate fixture quantity and length required to provide a continuous band of light without gaps to within 6" of row ends.

T. Accessible lens temperatures must not exceed 60°C.

2.2 Custom Fixtures

A. Custom fixture manufacturers must supply working sample and complete shop drawings to design team for review. Sample fixtures will become property of the Client or their design team.

B. Fixtures shall be U.L. approved for their proposed location, or listed with other approved listing agency.

C. Exposed hardware shall be concealed where appropriate unless as a design feature.

D. Custom fixture manufacturers shall have a minimum 5 years of experience in the design and manufacturing of lighting fixtures of the type, quantity and quality shown. Prequalification submissions must include a list of completed projects, dated catalog pages or drawings indicating length of experience.

E. Materials, accessories and other related fixture parts shall be new and free of any defects which in any manner may impair their character, appearance, strength or ability and function effectively protected from damage or injury from the time of fabrication until final acceptance of work.
F. Sheet metal shall be free from tool marks, and dents and shall have accurate angles as sharp as compatible with the gauge of the required metal. Intersections and joints shall be formed true of adequate strength and structural rigidity to prevent distortion after assembly.

G. Housing shall be so constructed that electrical components are easily accessible and replaceable without removing fixtures from their mountings or disassembly of adjacent construction.

H. Fixtures shall be completely wired at the factory. Fixtures shall come with electrical wire whips in accordance with local codes and in accordance with actual installation requirements.

I. Leaks within fixtures and between fixtures and mounting surface will not be tolerated.

J. Steel and aluminum fixtures, screws, bolts, nuts and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, hardware shall be stainless steel or bronze. Fixtures must be assembled and gasketed properly to prevent galvanic action.

2.3 Suspended Fixtures

A. Where fixtures are mounted in a continuous row, fixtures eight feet in length shall have stems placed within 2 feet of fixture ends. Stems shall be spaced symmetrically. A fixture four feet or three feet in length, placed in rows shall have a stem connected to the center fixture.

B. Individual fixtures that are four feet in length shall have two stems placed approximately three inches from the end.

C. Suspended fixtures shall be Stainless Steel Type 304 1/16-inch diameter aircraft cable minimum. Contractor to verify cable diameter requirement with the lighting manufacturer. Ceiling swivels shall be of the ball aligner type permitted on the drawings. Chain suspension may be used only where specifically permitted on the drawings. Chain shall be heavy duty, nickel-plated suitable for the weight of specific fixtures.

D. Provide redundant support for pendant-mounted fixtures.

2.4 Low Voltage Lighting

A. Where remote transformers and/or drivers are specified, transformers must be installed in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 38°C.

B. Transformers/drivers shall be rated for operation on the electrical system voltage to which they are shown connected.

C. Transformers/drivers should be mounted as close to the feed luminaire as practical to keep the secondary feed as short as possible.

D. Low voltage transformers shall be fused on the primary and secondary side with protection devices sized as appropriate to conductors, lamps, and transformers.

E. Contractor is responsible to lay out and install low voltage systems to prevent excessive light loss due to voltage drop.

F. Contractor to install the system to meet local codes.

2.5 Lenses
A. Plastic used for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohm & Haas, Dupont, or acceptable equal, unless otherwise noted.

B. Glass used for lenses, reflectors, diffusers, and luminaires shall be tempered for high impact and heat resistance. The glass shall have a transmittance of not less than 88%, unless otherwise indicated.

C. Lenses, louvers, and other light diffusing elements shall be removable and positively held so that hinging or other normal motion will not cause them to drop out.

D. Lenses shall be turned over to the Owner clean and free of dust or finger prints.

2.6 Lamps

A. Provide lamps as indicated on the luminaire schedule and the applicable contract documents.

B. Lamps of a given type shall be produced by one manufacturer.

C. Provide 10% spare lamps for fixtures.

2.7 LED Light Source

A. All luminaires shall meet the following standards:

1. Low Maintenance / Long life LED.
   a. >60,000 Hours at 70% lumen maintenance.
   b. Minimum of 5 year warranty.

2. Ease of maintenance
   a. Driver and emergency battery module are easily removable for servicing.

3. Flexibility
   a. Universal Voltage Driver to operate by 0-10v dimmers, sensors or switches.
   b. Must be a minimum of >98% power factor, 120-277V.
   c. Optical performance to deliver superior color mixing and beam uniformity.

4. Made in the USA
   a. Drivers, battery packs and light engines to be designed and manufactured in the USA. Contractor to provide verifiable documentation as to the Made in USA requirement.

PART 3 - Execution

3.1 Installation

A. Provide luminaires at locations, and of types, as indicated on the contract drawings.

B. Contractor shall be responsible for coordinating with the other trades to ensure and maintain adequate recess clearance as lighting positions are critical and shall take precedence over other concealed building systems.
C. Contractor shall be responsible for installing fixtures with proper ventilation so as not to exceed the temperature rating of the lighting fixtures or lamps.

D. Notify the Architect about field conditions at variance with plans and/or specifications before commencing installation. Failure to do so shall exonerate the Architect from responsibility for problems resulting from same, and work required to correct the discrepancy shall be performed by the Contractor with no additional compensation.

E. Prior to ordering lighting equipment, the Contractor shall verify locations and recess depths, final voltages, and ceiling trims compatibility. Additional charges for failure to verify locations will not be allowed.

F. Plaster frames for recessed fixtures shall be installed in a rigid manner so as not to allow fixture frame or housing to move or shift when trim is removed or fixture is re-lamped.

G. For bracket-mounted fixtures, provide metal plate attached to outlet box with threaded holes suitable for supporting the fixture rigidly in design position. Studs shall be steel or malleable iron, and galvanized. Die cast studs shall not be used. Electrical boxes shall be securely mounted and not move in the wall or shall be reset and wall refinished at the Contractor’s expense.

H. Where required by the local building or health department, provide approved wire guards and or plastic sleeves over fixtures.

I. Install luminaires properly and safely. Provide hangers, rods, mounting brackets, supports, frames, yokes, support bars and other equipment required for a complete installation.

J. Luminaires shall be complete with lamps of the type noted in the schedules and shall have metal parts, glassware, plastic diffusers etc., free from scratches, cracks, and other defects. Items damaged during shipment handling, or installation shall be replaced without expense to the Owner.

K. Fixtures installed with plastic lenses shall be cleaned and de-staticized after installation. Install and leave with no fingerprints or dirt marks on the lens or diffuser. Use white gloves if necessary.

L. Luminaires and lamps must be operational at time of turn over to the owner.

M. Luminaires to be cleaned prior to opening the facility.

N. Luminaires shall be packaged with complete instructions and illustrations showing proper installation procedures. Install luminaires in strict conformance with manufacturer's recommendation and instructions.

O. Contractor is required to protect fixtures from damage during installation and up to time of acceptance by the Architect. Broken fixtures, glassware, plastics, lamps etc. must be replaced by the Contractor with new parts without expense to the owner.

P. Fixtures shall be installed so that no labels will be visible under normal operating conditions of the fixture.

Q. If fixtures are installed in a fire rated ceiling, the Contractor will preserve the fire rating according to the UL assembly number.

R. Install lamps in fixtures as needed.
S. Wall slot fixtures are to be installed prior to the finishing of walls where they are found. They are to be used as the sole work light when finishing the adjacent wall.

T. Matte white face plates for pinhole and slot downlights shall be painted prior to installation to match the soffit in which each is to be located.

U. Remote transformers and drivers shall be concealed in dry, accessible locations unless otherwise directed.

3.2 Aiming and Adjustments

A. Adjustable lighting units shall be aimed, focused, and locked, etc., by the Contractor under the supervision of the Architect.

B. Aiming and adjusting shall be carried out after installation is complete. Ladders and scaffolding, etc., required shall be furnished by the Contractor at the direction of the Architect. As aiming and adjusting is completed, locking setscrews, bolts, and nuts shall be tightened securely.

C. Where possible, units shall be focused during normal working daytime hours. However, where daylighting interferes with aiming and focusing, the aiming shall be performed at night.

3.3 Coordination with Ambient Conditions

A. The Contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions which will exist when the luminaires are installed. These areas of coordination include, but are not limited to, the following:

1. Wet location labels.
2. Damp location labels.
3. Low temperature drivers.
4. Dimming drivers.
5. Very low heat rise drivers.
6. Plenums and air handling spaces.
7. Fire rated ceilings.
8. Low density ceiling.
9. Insulated ceilings.

3.4 Site Environmental Procedures

A. Resource Management:

1. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.
   a. Dimming Drivers: Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.
   b. Occupancy Sensor: Test sensors for proper operation. Observe for light control over entire area being covered.

End of Section 26 51 00
Section 27 05 00 - Common Work Results for Communications

PART 1 - General

1.1 Section Includes

A. Related Sections
B. Summary
C. Codes and Specifications
D. General Requirements and Conditions
E. Qualifications of Subcontractors
F. Product Requirements
G. Structured Cabling System
H. Submittals
I. Record Drawings
J. Definitions

1.2 Related Sections

A. Telecommunications General Requirements specifically applicable to Division 27 Sections, in addition to Division 1 General Requirements and Drawings.
B. Section 27 05 26 – Grounding and Bonding for Communications Systems
C. Section 27 05 28 – Pathways for Communications Systems
D. Section 27 05 36 – Cable Trays for Communications Systems
E. Section 27 05 44 – Sleeves and Sleeve Seals for Communications Pathways and Cabling
F. Section 27 11 00 – Communications Equipment Room Fittings
G. Section 27 13 00 – Communications Backbone Cabling
H. Section 27 15 00 – Communications Horizontal Cabling

1.3 Summary

A. Scope of Work

1. The scope of work includes the design, provision, installation, testing, and documentation of pathways and media resources for voice and data systems required by the construction documents for the “Owner’s Name”
2. The Contractor will provide all labor, materials, tools, equipment, and permits necessary for the satisfactory and timely completion of the project. This project includes furnishing and installing all inter-building pathways and spaces, backbone fiber and copper cables and outside plant copper from the Main Distribution Frame; aka MDF to the each of the Intermediate Distribution Frame (IDF) Closets. This project includes all intra-building pathways, fiber, and copper cables for a complete and operable technology structured cabling system to support telecommunications.

3. The Contractor and Owner shall jointly implement this project such that it meets the technical requirements of the construction documents and employs all consideration necessary to create minimum impact on the campus operations and academic environment.

B. Statement of Work

1. The work includes, but is not limited to, the items outlined in these construction documents, as well as all incidental items and design required to provide complete and operable systems. The Owner and the Contractor shall mutually agree on the general conduct of the work prior to initiation of construction and shall each be responsible for following these general guidelines throughout the construction period unless modified in writing based upon discussions at the project coordination meetings.

2. Upon completion of the Project the Contractor shall provide Connectivity Design Documentation that includes, but is not limited to, the following:
   a. Complete set of floor plans indicating all telecommunications outlets installed. Floor plans shall have outlet numbering indicated on plans. (Hardcopy and Electronic copy)
   b. Cable test results in Hardcopy and Softcopy.
   c. As-built documentation identifying cable trays, major conduit routing, MDF, IDF and ALL cabinet layouts complete with locations of all major components. As-built documentation to be delivered in AutoCAD version 2014, (3) printed full size sets and (2) sets on CD.

1.4 Codes And Standards

A. All work shall be performed in compliance with the most restrictive of Municipal, State, and/or Federal Codes which may govern this work and shall conform to the latest published version following codes and specifications:

1. National Fire Protection Association

2. ANSI Specifications:
   b. ANSI/ICEA S-83-596 - Fiber Optic Premises Distribution Cable Technical Requirements.

3. BICSI Standards:
   a. NECA/BICSI 607 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

4. Electronics Industries Association/Telecommunications Industry Association (EIA/TIA):
   a. TIA/EIA-568-C - Commercial Building Telecommunications Wiring Standard
b. TIA/EIA-569-B - Commercial Building Standard for Telecommunications Pathways

c. TIA/EIA 606 B - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

d. ANSI/TIA 607-B - Commercial Building Grounding (Earthing) and Bonding Requirements or Telecommunications.

e. EIA-310-D - Cabinets, Racks, Panels, and Associated Equipment.

f. TIA/EIA 526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.

g. TIA/EIA 455-57-B - Optical Fiber End Preparation and Examination.

h. TIA/EIA 455-59 - Measurement of Fiber Point Defects Using an OTDR.

i. TIA/EIA 455-60 - Measurement of Fiber Cable Length Using an OTDR.

j. TIA/EIA 455-61 - Measurement of Fiber Cable Attenuation Using an OTDR.

k. TIA/EIA 455-95-A - Absolute Optical Power Test for Optical Fibers and Cables.

l. EIA RS-458A Standard Optical Waveguide Fiber Material Classes and Preferred Sizes.

m. EIA-472 Generic Specification for Optical Waveguide Fibers.

n. ANSI/TIA/EIA 526-14A – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

o. ANSI/TIA/EIA 526-7 - Measurement of Optical Power Loss of installed Single-mode Fiber Cable Plant


6. Title 24 - State of California Code of Regulations.


10. Occupational Safety and Health Act (OSHA) Specifications.

11. City or County Electrical Code, as applicable.

12. IEEE Specifications:

   a. IEEE 802.2 Logical Link Control Working Group

   b. IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

   c. ANSI/IEEE Std. 1100 Recommended Practice for Powering and Grounding Electrical Equipment


13. NEMA VE1 Cable Tray Systems.

14. NEMA VE2 Cable Tray Installation Guidelines

15. Underwriters Laboratories Specifications:

   a. UL 497 Electrical Grounding and Bonding Equipment.

   b. UL 1479 Fire Tests of Through-Penetration Firestops.


16. The Uniform Mechanical Code.

17. ASTM Specifications:

   a. ASTM E 814 Methods of Fire Tests of Through-Penetration Fire Stops.

   b. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

19. Americans with Disabilities Act (ADA).

B. Where the Construction Documents make reference to a requirement that exceeds minimum code requirements or requirements of the Standards and Guidelines referred to above, the Construction Documents shall take precedence. The Contractor and Construction Administrator shall jointly resolve any work that is in apparent conflict with applicable codes.

C. In accordance with these laws, rules, and regulations, the Contractor shall provide the following:

1. Any additional material and labor that may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications.
2. All permits required by any of the legally-constituted public authorities for the installation or construction of the work.
3. Any inspection or examinations required. Copies of certificates of all such inspections shall be delivered to the Construction Administrator.
4. If any work is concealed without proper inspection and approval, the Contractor shall be responsible for all work required to open and restore the concealed areas, in addition to all required modifications.

1.5 General Requirements And Conditions

A. Safety

1. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of persons and property during performance of work.
2. The Contractor shall ensure that all personnel working in or anywhere on the site shall be provided a hard hat, safety shoes, a face shield or safety goggles, etc. for their protection.
3. If required by the campus, all personnel working in or anywhere on the site shall display a photo-ID.
4. The Contractor shall ensure that all personnel working in or anywhere on the site shall conform to any regulations regarding confined space.
5. No act, service, drawing review, or construction observance by Owner or any other party employed by the same is intended to include review or approval of adequacy of the Contractor’s safety measures, in, on, or near the construction site.

B. Quality Assurance

1. The specifications contained herein are set forth as the minimum acceptable requirements of the Contractor’s Quality Assurance program. The Contractor is responsible for executing any other Quality Assurance measures necessary to ensure complete and fully functioning systems within the scope of this project.
2. The Contractor shall ensure that all design, workmanship, materials employed, required equipment, and the manner and method of installation conforms to accepted practices. Where specific specifications do not apply, the more stringent of industry publications, and campus policies, manufacturer’s guidelines, or previous (similar) work at the project site shall apply.
3. The Contractor shall also ensure that each piece of equipment is in satisfactory working condition.
4. The Contractor shall certify that the cable manufacturers have carried out the quality assurance tests and procedures as specified herein. All cable must be manufactured by an ISO9001 Certified Manufacturer.
   a. The Contractor is responsible for ensuring that the cable packaging for shipping/storage purposes meets or exceeds the following requirements:
   b. One continuous length of cable per shipping reel/container.
c. Reels must be wooden or steel, sturdy, lagged, and shall have thermal protection jackets applied prior to lagging.

d. Each reel/container shall be individually identified and marked with the length of the cable it contains. Said marking shall withstand weather and shipping conditions and remain readable.

e. For fiber optic cable, results of the 100% Attenuation tests conducted at the factory shall accompany each reel and shall be retained on site for owner review if necessary.

f. Cable shall be packed in a manner that facilitates the pre-installation tests to be conducted while the cable is still on the reel (i.e., both ends of the cable must be accessible while protected from moisture).

g. The Quality Assurance Plan employed shall include on-reel testing of fiber, and UTP, including, but not limited to, OTDR, power loss, attenuation, etc. (as applicable for given cable media).

C. Manufacturer’s Literature: Where these specifications call for an installation to be made in accordance with the manufacturer's recommendations, a copy of such recommendations shall always be kept on the job site and shall be available to campus project staff.

D. Acceptance of Telecommunications Work

1. The Contractor must demonstrate successful completion of the following tasks for the Owner to accept the telecommunications work:

a. Before executing any performance testing, the Contractor shall present a test plan to the Engineer of Record and Owner IT Staff for approval.

b. The Contractor has completed all testing and delivered copies of all test results to the Engineer of Record.

c. All test results have been examined and approved by the Owner and Engineer of Record.

d. Copies of all documentation required by this section have been delivered to the Engineer of Record.

e. All punch list items are completed to the satisfaction of the project manager or Inspector of Record.

f. Structured Cabling System Certification is provided to the Owner.

2. Minor failures such as incomplete resolutions to punch list items shall be responded to at the Owner’s discretion or within one business day.

E. Guarantee and Warranties

1. The installed structured wiring (as applicable for given cable media) system, including both inter- and intra-building sub-systems, shall be a Structured Cabling System, certified for maximum period benefiting the Owner. Structured Cabling Systems (SCS) wiring is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity from each data or voice outlet to the termination equipment and hardware providing connection to network file servers or voice network/switch designated as the service point for the Owner network.

2. The Customer’s Cable Infrastructure Project requires a <Manufacturer’s Name> structured cabling system single-manufacturer solution. The copper and fiber cabling systems shall comply with the link performance requirements of ANSI/TIA-568-C. The cabling system shall be backed by <Manufacturer’s Name> <Number of Years>-Year Product and Applications Assurance Warranty. The system warranty shall be facilitated by the Contractor and be established between the Customer and <Manufacturer Name>. The successful Contractor is required to furnish all
labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed. The Contractor shall be a <Manufacturer’s Name> Certified Installer, and shall maintain current status with the warranting manufacturer, including all training requirements, for the duration of the Cable Infrastructure Project. The Contractor shall staff each installation crew with the appropriate number of trained personnel, in accordance with the <Manufacturer’s Name> Certified Installer Program requirements and the performance Warranty contract agreement or equal, to support the <Number of years>-Year System Warranty requirements. After installation, the Contractor shall submit all documentation to support the warranty in accordance with the <Manufacturer’s Name> Certified Installer requirements or equal, including test results, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

3. Copies of any extended material warranties shall be passed through to the owner’s representative.

4. During the installation and up to the date of final acceptance, the Contractor shall protect all finished and unfinished work against damage and loss. In the event of such damage or loss, the Contractor shall replace or repair such work at no cost to the Owner.

1.6 Qualifications Of Subcontractors

A. All subcontractors employed by the Contractor shall have a minimum of 5 years’ experience in satisfactory completion of jobs of similar scope and amount.

B. The Contractor shall compile detailed information relating to similar work completed by all subcontractors employed for this project, including corporate references, to enable the Owner to evaluate and agree to the subcontractors’ responsibility, experience, and capacity to perform the work.

C. Each subcontractor employed by the Contractor to perform telecommunications work on this project shall possess a C-7 (formerly C-61) Limited Specialty License for Telecommunications and must be certified to install, terminate, splice, and test copper cables, fiber optic cable, riser cable, and inside wiring. This requirement ensures integration into, support, maintenance, and warrantee by the Contractor of the Owner’s new telecommunications infrastructure. The appropriate subcontractor’s license for underground construction and conduit installation is also required.

D. An on-site Contractor superintendent must be available at all times. Contact can be by person, telephone, or mobile device.

1.7 Product Requirements

A. General Information

1. These specifications identify the minimum specifications for product quality acceptable on this project by designating a manufacturer’s trade or brand name and catalog or model number and by describing attributes, performance, or other specifications.

2. Where applicable, the most recent manufactured product line consistent with the structured cable system supplier identified in the technical specification sections is to be the minimum standard for quality and performance of products to be used on this project.

3. For any product described only by attributes, performance, or directed by the specifications, the Contractor shall develop a Product Submittal in accordance with the requirements set forth herein. All Product Submittals must be reviewed by the Architect prior their use and installation on the project.

4. Such phrases as “or equal,” “or equivalent,” and “or acceptable substitute” indicate that an equivalent product may be proposed as a substitute for that which is specified. The proposed
substitution must meet or exceed the attributes, performance, or other specifications of the specified product and must be approved by the Owner.

5. Failure of the Contractor to submit proposed substitutions for approval in the manner described above shall be sufficient cause for disapproval by the Owner of any substitutions otherwise proposed.

6. Physical samples may be required. If tests to determine equality and utility are required by the Owner, they shall be made by a testing laboratory with the acceptance of the test procedure first given by the Owner, at the expense of the Contractor.

B. Quality of Materials

1. All materials and equipment supplied by the Contractor shall be new, manufactured within one (1) year prior to installation, and meet or exceed the latest published specifications of the manufacturer. All material shall be acceptable to and approved by the Architect as meeting these specifications.

2. All communications materials used on this project shall conform, where applicable, to the following specifications, unless otherwise noted:

   a. NEMA - National Electrical Manufacturers Association.
   b. ANSI - American National Specifications Institute.
   c. UL - Underwriters Laboratories, Inc.
   d. The latest IEEE and TIA/EIA 568 specifications.

3. Telephone system materials and equipment shall be FCC Type-accepted and certified as such by supplier.

4. No material employed shall present environmental or toxicological hazards as defined by current industry specifications. All materials shall comply with CAL OSHA and EPA specifications or applicable federal or state laws or regulations.

5. The equipment, apparatus, and material for fiber optic equipment and apparatus shall conform to existing CAL OSHA health and safety laws. The equipment and apparatus shall have provision for application of safety labels, such as LASER identification, or warning labels as required by system considerations.

C. Materials Delivery and Storage

1. Costs of all accelerated or non-standard shipping to the site, inside handling, and all unusual storage requirements shall be borne by the Contractor.

2. The Contractor shall make appropriate arrangements and coordinate with authorized personnel at the site for the proper acceptance, handling, protection, and storage of materials so delivered.

3. All materials delivered to the site shall be received, handled, and stored by employees of the Contractor.

1.8 Submittals

A. Structured Cabling System Pre-Qualification Certificate: The Contractor shall submit a letter of approval from the manufacturers indicating that he meets the qualifications as stated under the Guarantee and Warranty section (1.5.E). Documentation shall include training certificates for installation of the proposed products. These documents shall be submitted for approval with the first telecommunications product submittals.

B. Shop Drawings and Supplemental Data
1. Copies of shop drawings and supplemental data shall be provided for the engineer’s review. Shop drawings shall be submitted for all communications equipment, cabling, and structure pertaining to the job (distribution frames, conduit, wire, fiber optic cable, terminations, splices, etc.).

2. Design submittals (reflecting field conditions, actual cable lengths, equipment elevations, and performance expectations) shall be prepared for each system included in the project scope and reviewed with Engineer of Record.

3. Copies of final shop drawings and supplemental data, where called for, shall be submitted to the Engineer of Record. Final corrected copies of schedules and shop drawings or supplemental data shall be as follows (exceptions shall be noted in Specification Sections):
   a. One (1) for the Telecommunications Engineer’s files.
   b. Two (2) for Owner.
   c. One (1) to the Contractor’s job files and additional copies as the Contractor may desire for office files and/or for distribution to subcontractors or vendors.

4. The shop drawings and supplemental data called for shall be submitted as the instruments of the Contractor, even though they may have been prepared by a subcontractor, supplier, dealer, manufacturer, or by any other person, firm, or organization. Prior to submission, the Contractor shall conduct a review and stamp with acceptance and then submit to Engineer of Record for final review. By accepting and submitting shop drawings and supplemental data, the Contractor has determined and verified all field measurements, the physical construction, the quality of materials, the applicability of catalog numbers, and similar data. The Contractor has also checked and coordinated each shop drawing with the requirements of the field conditions and resolved conflicts between trades prior to the actual construction.

5. All shop drawings shall be drawn accurately (AUTOCAD) on paper suitable for duplicate copying by black, blue line printing processes or Xerox. Shop drawings shall be submitted on plans sized at 30” x 42”.

6. Supplemental data shall include information as noted in the specification paragraphs requiring them.

7. Engineer of Record will review shop drawings and supplemental data submitted by the Contractor only for general design conformance with the concept of the project and compliance with the information given in the Contract Documents. A review status of “No Exceptions Taken” on a submittal does not relieve the contractor of the requirements to comply with building codes or the contract specifications.”

8. Shop drawings shall be submitted for review and approval by the Engineer of Record prior to use on the job.

9. Shop drawings delineation: The shop drawings shall be drawn to scale and shall be completely dimensioned, giving the plan together with such sections as are necessary to clearly show construction detail.

10. Responsibility
   a. The Contractor or Contractor’s suppliers shall prepare the shop drawings and all supporting data, catalogs, etc. The Contractor shall check all drawings before submission.
   b. In particular, the Contractor shall insure that the drawings meet all requirements of the drawings and specifications and also conform to the structural and space conditions.
   c. Each shop drawing submitted for Owner approval shall bear a stamp certifying that the Contractor in accordance with the specifications has checked it. If such shop drawings show variations from Contract Documents, whether because of standard shop practice or other reasons, the Contractor shall make special mention thereof in the transmittal letter.
   d. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping, connections, wiring, manner of installation etc. that may be required by the proposed equipment to accommodate any work affected under other parts, headings, or divisions of Drawings and Specifications.
11. Identification: Shop drawings shall be titled with the name of the project on each sheet and shall otherwise be identified by listing the particular division, section, article or reference of the work to which they pertain. Different items shall be submitted on separate sheets, and all submittals shall be numbered serially.

12. Manner: The Contractor shall furnish separate submittal sheets for each specialty item for engineer of records approval in the following manner:
   a. Three (3) copies of catalog cuts shall be submitted. The cut sheets shall be photocopied or reproduced in some other acceptable manner on one side only of an 8 1/2” x 11” sheet, noting only the items in question, together with the descriptive (specification) data.
   b. Submittals shall be provided in a three ring binder with a table of contents clearly outlining each submittal and its related section.
   c. Each sheet shall be identified with the division, section, article or reference in the Contract Documents that covers the item submitted for approval.
   d. Each sheet shall be identified with the project name.
   e. The cover of the submittal shall bear the Contractor’s stamp and signature of approval.
   f. All submittals for low voltage cabling systems shall be submitted as one (1) package in the format as noted above. Individual specifications submittals or submittals not submitted as noted above shall not be accepted and shall be returned as “not reviewed”.

1.9 Record Drawings

A. The Contractor shall keep one set of drawings on site to continually maintain an accurate record of the as-constructed work. As constructed work shall be noted in RED on drawings for periodic review by EOR.

B. The marked-up drawings shall accurately indicate location of equipment, pull-boxes, conduits, cable types and labeling.

C. Final Record Drawings will be the responsibility of the contractor.

D. Within 30 days of completing work, the Contractor shall submit Three (3) copies of record drawings to the owner’s representative for review and final approval. Record drawings shall clearly indicate as-built conditions of the site along with necessary labeling of all outlets, pathways and any other items noted in the specifications. Record drawings or as-builts submitted with RFI #’s and clouds indicating where the RFI was applied will not be considered a record drawing or an as-built drawing unless the modification is clearly identified on the drawings. Drawings received with only RFI’s noted will be rejected without review.

E. In addition, the Contractor shall provide an electronic copy of the as-built drawings in a format specified (Auto CAD 2014 or Higher) by the owner’s representative.

1.10 Definitions

A. Backboard: Backboard generally refers to the A-C, fire-retardant, plywood sheeting lining the walls of the telecommunications facilities. Backboards may also refer to the entire wall-mounted assembly, including wire management and termination frames.

B. Building Distribution Frame (BDF): The BDF is the location within a building where the entire inside cable and fiber optic plant originates. The entire cable and fiber optic entrance facilities also terminate here. Part of the Horizontal Distribution System may originate here as well. It may include: the physical location, enclosure, wire and copper cable management hardware, fiber and management hardware, termination hardware, distribution hardware, protection hardware, active electronic components, and
equipment racks. EIA/TIA-569 "Commercial Building Standard for Telecommunications Pathways and Spaces" refers to the room housing the BDF as the Equipment Room. Throughout this specification, BDF and Telecommunications Equipment Room are equivalent.

C. CATV: Cable Antenna Television system.

D. Cable Plant: Cable, conduit raceways, vaults, junction/pull boxes, rooms, racks, equipment, patch bays/blocks, and other infrastructure required to provide physical, electrical, optical connectivity between buildings.

E. Cable Rack: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wiring inside the MDF, BDF, or IDF rooms.

F. Cable Tray: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wire from the MDF, BDF, or IDF to the Information Outlet access point.

G. Copper Entrance Cable: Copper Cable that joins the Owner’s backbone infrastructure at its connecting point to the building’s BDF.

H. Designation Strips: Paper or plastic strips, usually contained in a clear or color tinted plastic carrier, designated for insertion into a termination frame. Designation strips are usually imprinted with the adjacent terminal number and are used to aid in locating a specific pair, group of pairs, or information outlet inserted into the termination frame, or for the purpose of delineating a termination field.

I. Entrance Conduit: Conduit that connects the Owner’s underground infrastructure with the building's BDF.

J. Fiber Entrance Cable: Fiber Optic cable that joins the Owner’s backbone infrastructure at its connecting point to the building’s BDF.

K. Horizontal cables: Cables linking the information outlets with the IDF or BDF.

L. Information Outlet: An integral assembly containing one of the following:

1. Outlet used for voice and data services consisting of one, two, three or 4, 4 pair category 6A jacks that can be used for various services (voice, data, network, etc.).
2. The standard outlet for voice telephone service will consist of one, 4 pair category 6A, jack mounted in wall phone faceplate.
3. The category 6A jacks shall be mounted in faceplates that are secured to standard metal electrical outlet boxes or non-metallic communications surface mounted boxes. Blank dust cover(s) shall be provided in the unused faceplate positions.

M. Inside Plant (ISP): Communications system inside a building (wire, fiber, coaxial cable, equipment and racks, information outlets, etc.).

N. Intermediate Distribution Frame (IDF): The IDF is the location in a building where a transition between the Riser System and the Horizontal Distribution System occurs. It may include: the physical location, enclosure, wire and cable management hardware, fiber and management hardware, active electronic components, termination hardware, and equipment racks. EIA/TIA-569-A, "Commercial Building Specifications for Telecommunications Pathways and Spaces” refers to the IDF as the Telecommunications Closet. Throughout this specification IDF and Telecommunications Closet/Room are equivalent.
O. LAN: Local Area Network.

P. Main Distribution Frame (MDF): The MDF is the location, within a building, where the entire outside copper cable and fiber optic plant terminates. It may include the physical location, enclosure, wire, fiber, and copper cable hardware, protection, active electronic components, equipment frames and racks. EIA/TIA –569-A “Commercial Building Standard for Telecommunications Pathways and Spaces”: refers to the room housing the MDF as the Main Equipment Room.

Q. MPOE: Minimum Point of Entry, Utility Partnerships/Alternate Carrier, located within the MDF.

R. Management Hardware
1. Fiber Management: Hardware designed and manufactured for the purpose of keeping fiber patch cords neat and orderly. Most termination frame manufacturers provide fiber management components designed to work in conjunction with their termination frames. Fiber management may also refer to other types of hardware for the purpose of securing fiber optic cable to the building.
2. Wire Management (Copper, Data, Network): Hardware designed and manufactured for the purpose of keeping cross-connect wire and patch cables neat and orderly. Most termination frame manufacturers provide wire management components designed to work in conjunction with their termination frames. Wire management may also refer to other types of hardware for the purpose of securing wire and cable to the building.

S. Outside Plant (OSP): Communications system outside of the buildings (typically underground conduit and vaults, exterior/underground, aerial, and buried rated wire and cable, etc.).

T. Provide: Supply, furnish, deliver, install, terminate, label, test, ground and document the components per these specifications.

U. Riser Cable: High volume cable (copper) that connects the BDF with the IDF or backboards located on the same or different floors.

V. Riser Conduit: Conduit that connects the BDF to the IDF or backboards located on the same or different floors.

W. Riser Fiber Cable: Fiber Optic Cables that connects the BDF with IDF or backboards located on the same or different floors.

X. SPOE: Secondary Point of Entry, Utility/Alternate Carrier Partnership in buildings other than the MDF.

Y. Station Wire: 4 pair, unshielded, twisted pair, category 6A wire that connects the information outlet to the BDF or IDF.

Z. Telecommunications Ground: An electrical ground (as defined by local codes), usually the main building ground electrode extended by a continuous AWG "3/0" wire to ground bus bars in the BDF, IDF, and roof telecommunications terminal point.

AA. Termination Fields
1. Copper, Data, Network Termination Fields: A group of termination frames clustered together to provide terminations for specific cable or inside wiring groups, where all of the cable or wiring in the group is used for a single purpose, constitutes a copper, data, or network termination field. The extent of a specific field, located in a group of fields, may be distinguished by a physical
separation between the frames forming the field, by uniquely colored designation strips, or by a series of terminal numbers.

2. Fiber Optic Termination Fields: A group of termination frames clustered together to provide terminations for fiber optic cable fibers, where all of the cable fibers are used for a single purpose, constitutes a fiber termination field.

BB. Termination Frames

1. Copper Termination Frame: Device designed and manufactured for the purpose of terminating large numbers of copper cable or station wire pairs. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Copper Termination Frame and Wiring Block are equivalent.

2. Data Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Data Termination Frame and/or Data Patch Panel are equivalent.

3. Fiber Termination Frame: Device designed and manufactured for the purpose of terminating fiber optic cable fibers into a connector field.

4. Network Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Network Termination Frame and Network Jack Panel are equivalent.

PART 2 - Materials

Not used

PART 3 - Execution

3.1 Seismic Requirements: General

A. Earthquake-resistive design shall comply with the requirements of the 2013 California Building Code (CBC).

B. Equipment and piping shall be braced in accordance with the most current edition of Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA) with Addendum No. 1 and National Uniform Seismic Installation Guidelines (NUSIG).

End of Section 27 05 00
Section 27 05 26 - Grounding and Bonding for Communications Systems

PART 1 - General

1.1 Summary

A. Section Includes:
   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding rods.
   5. Grounding labeling.

1.2 Definitions

A. BCT: Bonding conductor for telecommunications.
B. EMT: Electrical metallic tubing.
C. TGB: Telecommunications grounding busbar.
D. TMGB: Telecommunications main grounding busbar.

1.3 Action Submittals

A. Product Data: For each type of product.

1.4 Informational Submittals

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   1. Ground rods.
   2. Ground and roof rings.
   3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.
C. Qualification Data: For testing agency and testing agency's field supervisor.
D. Field quality-control reports.

1.5 Closeout Submittals

A. Operation and maintenance data.

1.6 Quality Assurance

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under the direct supervision of ITS Installer 2, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as ITS Installer 2 to perform the on-site inspection.

PART 2 - Products

2.1 System Components

A. Comply with J-STD-607-A.

2.2 Conductors

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
   1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
   2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 Connectors

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
   1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 Grounding Busbars

A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 Labeling

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 Examination

A. Examine the ac 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 the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.
3.2 Installation

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.3 Application

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Conductor Terminations and Connections:

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.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 Grounding Electrode System

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.
3.5 **Grounding Busbars**

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 **Connections**

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pretwist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG [168 kcmils] unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install [top-mounted] [vertically mounted] rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.
3.7 Identification

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 Field Quality Control

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

End of Section 27 05 26
SECTION 27 05 28 - Pathways for Communications Systems

PART 1 - General

1.1 Summary

A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Optical-fiber-cable pathways and fittings.
   4. Metal wireways and auxiliary gutters.
   5. Nonmetallic wireways and auxiliary gutters.
   7. Nonmetallic surface pathways.
   10. Polymer-concrete handholes and boxes for exterior underground cabling.

1.2 Action Submittals

A. Product data for each type of product.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 Informational Submittals

A. Coordination Drawings: Pathway routing plans, drawn to scale and coordinated with each other, using input from installers of items involved.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - Products

2.1 Metal Conduits and Fittings

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
   2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.
2.2 Nonmetallic Conduits and Fittings

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651A.

F. RTRC: Comply with UL 2515A and NEMA TC 14.

1. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Solvents and Adhesives: As recommended by conduit manufacturer.
2.3 Optical-Fiber-Cable Pathways and Fittings

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for riser installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

2.4 Metal Wireways and Auxiliary Gutters

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 Nonmetallic Wireways and Auxiliary Gutters

A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 Surface Metal Pathways

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
C. Comply with TIA-569-D.

2.7 Surface Nonmetallic Pathways:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Finish: Texture and color selected by Architect from manufacturer's standard colors.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.8 Hooks

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. stainless steel.

E. J shape.

2.9 Boxes, Enclosures, and Cabinets

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.

2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.

3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

5. Gangable boxes are allowed.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Metal Floor Boxes:


2. Type: Fully adjustable.

3. Shape: Rectangular.

4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
F. Nonmetallic Floor Boxes: Nonadjustable, round.
   1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures:
      b. Finished inside with radio-frequency-resistant paint.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - Execution

3.1 Pathway Application

A. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

B. Pathway Fittings: Compatible with pathways and suitable for use and location.

C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

D. Install surface pathways only where indicated on Drawings.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
3.2 Installation

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270528.29 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

Q. Surface Pathways:
   1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
   1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
   2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
   3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

S. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

V. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   3. 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 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

X. Mount boxes at heights indicated on Drawings. Install boxes with height measured to bottom of box unless otherwise indicated.

Y. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 Sleeve and Sleeve-Seal Installation for Communications Penetrations

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 Firestopping

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 Protection

A. Protect coatings, finishes, and cabinets from damage or 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 27 05 28
Section 27 05 36 - Cable Trays for Communications Systems

PART 1 - General

1.1 Summary

A. Section Includes:
   1. Ladder cable tray.
   2. Cable tray accessories.

1.2 Action Submittals

A. Product Data: For each type of product.
B. Shop Drawings: For each type of cable tray.
C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 Informational Submittals

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
B. Field quality-control reports.

PART 2 - Products

2.1 Performance Requirements

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component Importance Factor: 1.0.

2.2 General Requirements for Cable Trays

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
2.3 Ladder Cable Tray

A. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 3 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 12 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 12 inches.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:

1. Steel:
   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

1) Hardware: Galvanized, ASTM B 633.


1) Hardware: Galvanized, ASTM B 633.


1) Hardware: Galvanized, ASTM B 633.

g. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
2.4 Cable Tray Accessories

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 Source Quality Control

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - Execution

3.1 Cable Tray Installation

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Fasten cable tray supports to building structure and install seismic restraints.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

E. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

F. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

G. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

H. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

I. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

J. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

K. Install warning signs in visible locations on or near cable trays after cable tray installation.
3.2 Cable Tray Grounding

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 Cable Installation

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 Connections

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 Field Quality Control

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 Protection

A. Protect installed cable trays and cables.

End of Section 27 05 36
SECTION 27 05 44 - Sleeves and Sleeve Seals for Communications Pathways and Cabling

PART 1 - General

1.1 Summary

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 84 00 "Through-Penetration Firestop Systems for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 Action Submittals

A. Product Data: For each type of product.

PART 2 - Products

2.1 Sleeves

A. Wall Sleeves:

2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

2. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 Sleeve-Seal Systems

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel of length required to secure pressure plates to sealing elements.

2.3 Sleeve-Seal Fittings

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 Grout

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 Silicone Sealants

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - Execution

3.1 Sleeve Installation for Non-Fire-Rated Electrical Penetrations

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 Sleeve-Seal-System Installation
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
   B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 Sleeve-Seal-Fitting Installation
   A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
   B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
   C. Secure nailing flanges to concrete forms.
   D. Using grout, seal the space around outside of sleeve-seal fittings.

End of Section 27 05 44
Section 27 11 00 - Communications Equipment Room Fittings

PART 1 - General

1.1 Summary

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Power strips.
5. Grounding.

B. Related Requirements:

1. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 Action Submittals

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.3 Informational Submittals

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Certificates: For equipment frames from manufacturer.

1.4 Quality Assurance

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.
PART 2 - Products

2.1 Performance Requirements

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

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."

2.2 Equipment Frames

A. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

B. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug
2. Baked-polyester powder coat finish.

C. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 Grounding

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with TIA-607-B.
2.4 Labeling

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - Execution

3.1 Installation

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

   1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
   4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 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 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 Firestopping

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.
3.4 Grounding

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

   1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 Identification

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Labels shall be preprinted or computer-printed type.

End of Section 27 11 00
SECTION 27 13 00 - Communications Backbone Cabling

PART 1 - General

1.1 Summary

A. Section Includes:

1. Pathways.
2. UTP cable.
3. Cable connecting hardware, patch panels, and cross-connects.

1.2 Backbone Cabling Description

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.3 Performance Requirements

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.4 Action Submittals

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

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:
   b. Patch panels.
   c. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.

1.5 Informational Submittals

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
B. Source quality-control reports.

C. Field quality-control reports.

1.6 Closeout Submittals

A. Maintenance data.

1.7 Quality Assurance

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.8 Delivery, Storage, And Handling

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - Products

2.1 Pathways

A. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:

1. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion.
   a. Ladder Cable Trays: Nominally 12 inches wide, and a rung spacing of 12 inches.

C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."
1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 Backboards

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 Utp Cable

A. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP or MPG.
   f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 Utp Cable Hardware

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair cables in 48-inch lengths; terminated with 8-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 Grounding

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.6 Identification Products

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 Source Quality Control

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - Execution

3.1 Entrance Facilities

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 Wiring Methods

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
3.3  Installation Of Pathways

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4  Installation Of Cables

A. Comply with NECA 1.

B. General Requirements for Cabling:

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
3.5 Firestopping

A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 Grounding

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with ANSI-J-STD-607-A.
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 Identification

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: [1] [2].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 Field Quality Control

A. Tests and Inspections:

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. Prepare test and inspection reports.

End of Section 27 13 00
SECTION 27 15 00 - Communications Horizontal Cabling

PART 1 - General

1.1 Summary

A. Section Includes:
   1. UTP cabling.
   2. Multiuser telecommunications outlet assemblies.
   3. Cable connecting hardware, patch panels, and cross-connects.
   4. Telecommunications outlet/connectors.
   5. Cabling system identification products.

B. Related Requirements:
   1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 Administrative Requirements

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.3 Action Submittals

A. Product Data: For each type of product.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   2. Wiring diagrams to show typical wiring schematics, including the following:
      b. Patch panels.
      c. Patch cords.
   3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.4 Informational Submittals

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.
1.5 Closeout Submittals
A. Maintenance data.

1.6 Quality Assurance
A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.7 Delivery, Storage, And Handling
A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - Products

2.1 Horizontal Cabling Description
A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
   1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

2.2 Performance Requirements
A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 Utp Cable
A. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP or MPG.
   f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 Utp Cable Hardware

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Number of Jacks per Field: One for each four-pair.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.

2.5 Consolidation Points

A. Description: Consolidation points shall comply with requirements for cable connecting hardware.
   1. Number of Terminals per Field: One for each conductor in assigned cables.
   2. Number of Connectors per Field:
      a. One for each four-pair UTP cable indicated.
      b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
4. NRTL listed as complying with UL 50 and UL 1863.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.6 Multiuser Telecommunications Outlet Assembly (Mutoa)

A. Description: MUTOAs shall meet the requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:
   a. One for each four-pair UTP cable indicated.
   b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.7 Telecommunications Outlet/Connectors


B. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP work area cords.
   a. Flush mounting jacks, positioning the cord at a 45-degree angle.
3. Legend: Factory labeled by silk-screening or engraving.
4. Legend: Machine printed, in the field, using adhesive-tape label.

2.8 Grounding

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.9 Identification Products

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.10 Source Quality Control

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
C. Factory test UTP cables according to TIA/EIA-568-B.2.
D. Cable will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

**PART 3 - Execution**

3.1 **Entrance Facilities**

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 **Wiring Methods**

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 **Installation Of Cables**

A. Comply with NECA 1.

B. General Requirements for Cabling:

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 Firestopping

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 Grounding

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 Identification

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

   1. Administration Class: 1
   2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and...
pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 Field Quality Control

A. Perform the following tests and inspections:

2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connections, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. UTP Performance Tests:
   a. Test each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

   b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

   B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

   C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

   D. Prepare test and inspection reports.

3.8 Demonstration

   A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

End of Section 27 15 00
SECTIONS 280513 – Conductors and Cables for Electronic Safety and Security

PART 1 - General

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

1.2 Summary
   A. Section Includes:
      1. Fire alarm wire and cable.
      2. Identification products.

1.3 Definitions
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.4 Action Submittals
   A. Product Data: For each type of product.
   B. Shop Drawings:
      1. Cabling administration drawings and printouts.
      2. Wiring diagrams to show typical wiring schematics, including the following:
         b. Patch panels.
         c. Patch cords.

1.5 Informational Submittals
   A. Source quality-control reports.
   B. Field quality-control reports.

1.6 Quality Assurance
   A. Testing Agency Qualifications: An NRTL.
      1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
PART 2 - Products

2.1 Performance Requirements

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 Fire Alarm Wire and Cable

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

2.3 Identification Products

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - Execution

3.1 Installation of Hangars and Supports

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.
3.2 Wiring Method

A. Install wiring in metal pathways and wireways.
   1. Minimum conduit size shall be 3/4 inch. Control and data-transmission wiring shall not share conduits with other building wiring systems.
   2. Comply with requirements in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring on Racks and within Enclosures:
   1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM's "Cabling Termination Practices" chapter. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.
   2. Install lacing bars and distribution spools.
   3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
   4. Install conductors parallel with or at right angles to sides and back of enclosure.
   5. Connect conductors associated with intrusion system that are terminated, spliced, or interrupted in any enclosure onto terminal blocks.
   6. Mark each terminal according to system's wiring diagrams.
   7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 Fire Alarm Wiring Installation

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method:
   1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is permitted.
   3. Signaling Line Circuits: Power-limited fire alarm cables shall 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 the fire alarm system to terminal blocks. Mark each terminal according to the 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 the 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.

3.4 Connections
A. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.5 Firestopping
A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-C, "Firestopping" Annex A.
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 Identification
A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 28 05 13
Section 28 31 11 – Digital, Addressable Fire Alarm System

PART 1 - General

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Fire-alarm control unit.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
7. Magnetic door holders.
10. Digital alarm communicator transmitter.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 Action Submittals

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
b. Show field wiring required for HVAC unit shutdown on alarm.
c. Locate detectors according to manufacturer's written recommendations.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 Informational Submittals

A. Qualification Data: For Installer.
B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
C. Field quality-control reports.
D. Sample warranty.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For fire-alarm systems and components 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. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

c. Complete wiring diagrams showing connections between all devices and equipment.

d. Riser diagram.

e. Record copy of site-specific software.

f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

g. Manufacturer's required maintenance related to system warranty requirements.

h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 Quality Assurance

A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

B. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.7 Warranty

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 System Description

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. 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.

2.2 Systems Operational Description

A. Fire-alarm signal initiation shall be by one or more of the following devices:

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.
9. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate preaction system.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Activate emergency lighting control.
13. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Elevator shunt-trip supervision.
4. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of [200 seconds] <Insert time delay>, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 Performance Requirements

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

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."

2.4 Fire Alarm Control Unit

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, [80] <Insert number> characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, [Class B] [Class D] [Class E].
2. Pathway Survivability: [Level 0] [Level 1].

D. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.

3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

E. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.

3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters, and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 Manual Fire Alarm Boxes

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.

1. Single-action mechanism, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.
2.6 System Smoke Detectors

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be [four] [two]-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated[ and power-on status].
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition[ and individually adjustable for sensitivity by fire-alarm control unit].
   a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
   b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
   c. Multiple levels of detection sensitivity for each sensor.
   d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.


**2.7 Carbon Monoxide Detectors**

**A. General**

1. Mounting: Adapter plate for outlet box mounting.

2. Testable by introducing test carbon monoxide into the sensing cell.

3. Detector shall provide alarm contacts and trouble contacts.

4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.

5. Comply with UL 2075.

6. Locate, mount, and wire according to manufacturer's written instructions.

7. Provide means for addressable connection to fire-alarm system.

8. Test button simulates an alarm condition.

**2.8 Nonsystem Smoke Detectors**

**A. General Requirements for Nonsystem Smoke Detectors:**

1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.

2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

**B. Single-Station Smoke Detectors:**

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac [with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device].

2. Auxiliary Relays: One [Form C, rated at 0.5 A] [Form A and one Form C, both rated at 0.5 A].

3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.


5. Heat sensor, 135 deg F (57 deg C) [combination rate-of-rise and ]fixed temperature.

6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. **Tandem Connection**: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.

8. **Plug-in Arrangement**: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

9. **Self-Restoring**: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

10. **Integral Visual-Indicating Light**: LED type, indicating detector has operated and power-on status.

### C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.

2. Sensor: LED or infrared light source with matching silicon-cell receiver.
   
   a. **Detector Sensitivity**: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.

3. **Base Mounting**: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
   
   a. **Weatherproof Duct Housing Enclosure**: NEMA 250, Type 4X; listed for use with the supplied detector.

4. **Sampling Tubes**: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

5. **Relay Fan Shutdown**: Rated to interrupt fan motor-control circuit.

### 2.9 Heat Detectors

**A. General Requirements for Heat Detectors**: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

**B. Heat Detector, Combination Type**: Actuated by either a fixed temperature or a rate of rise.

1. **Mounting**: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

**C. Heat Detector, Fixed-Temperature Type**: Actuated by temperature that exceeds a fixed temperature.

1. **Mounting**: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
2.10 Notification Appliances

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Chimes: Vibrating type.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Mounting: Wall mounted unless otherwise indicated.
2. Flashing shall be in a temporal pattern, synchronized with other units.
4. Mounting Faceplate: Factory finished, [red] [white].

2.11 Remote Annunciators

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: [Flush] [Surface] cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 Addressable Interface Device

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal [to elevator controller to initiate elevator recall] [to circuit-breaker shunt trip for power shutdown] <Insert functions>.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
D. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.
   3. <Insert other functions>.

2.13 Digital Alarm Communicator Transmitter

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture [one] [two] telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.
   6. <Insert local function>.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 Equipment Installation

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

C. Equipment Mounting: Install fire-alarm control unit on finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

F. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

K. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 Pathways

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.
3.3 Connections

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

   1. Smoke dampers in air ducts of designated HVAC duct systems.
   2. Magnetically held-open doors.
   3. Electronically locked doors and access gates.
   4. Alarm-initiating connection to elevator recall system and components.
   5. Alarm-initiating connection to activate emergency lighting control.
   6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
   7. Supervisory connections at valve supervisory switches.
   8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
  10. Supervisory connections at fire-extinguisher locations.

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. Install framed instructions in a location visible from fire-alarm control unit.

3.5 Grounding

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 Field Quality Control

A. Field tests shall be witnessed by [Architect] [authorities having jurisdiction] <Insert names or titles of witnesses>.

B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:

Digital, Addressable Fire-Alarm System
28 31 11 - 13
1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 Software Service Agreement

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [two] <Insert number> years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [30] <Insert number> days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.
3.8 Demonstration

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11
Section 28 31 12 – Zoned (DC Loop) Fire Alarm System

PART 1 - General

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

1.2 Summary
A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   4. Nonsystem smoke detectors.
   5. Heat detectors.
   7. Magnetic door holders.
B. Related Requirements:
   1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 Action Submittals
A. Product Data: For each type of product, including furnished options and accessories.
B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.

5. Include voltage drop calculations for notification-appliance circuits.

6. Include battery size calculations.

7. Include input/output matrix.

8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

9. Include performance parameters and installation details for each detector.

10. Verify that each duct smoke detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
   a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
   b. Show field wiring required for HVAC unit shutdown on alarm.
   c. Locate detectors according to manufacturer's written recommendations.

12. Include floor plans to indicate final outlet locations showing zone designation of each device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician; [Level III] [Level IV] minimum.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 Informational Submittals

A. Qualification Data: For Installer.
B. Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.

C. Field quality-control reports.

D. Sample warranty.

1.5 Closeout Submittals

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following [and deliver copies to authorities having jurisdiction]:
   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide the "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment.
   d. Riser diagram.
   e. Record copy of site-specific software.
   f. Provide the "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.
   g. Manufacturer's required maintenance related to system warranty requirements.
   h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 Quality Assurance

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm [Level II] [Level III] [Level IV] technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

F. NFPA Certification: Obtain certification according to NFPA 72 by <Insert certification agency>.
1.7 **Warranty**

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: ![Five](<Insert number>) years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 **System Description**

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with and operate as an extension of existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded system dedicated to fire-alarm service only.

C. All components provided shall be listed for use with the selected system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 **Systems Operational Description**

A. Fire-alarm signal initiation shall be by one or more of the following devices[and systems]:

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.
9. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm zone at fire-alarm control unit[and remote annunciators].

3. Transmit an alarm signal to the remote alarm receiving station.

4. Unlock electric door locks in designated egress paths.

5. Release fire and smoke doors held open by magnetic door holders.

6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.

7. Close smoke dampers in air ducts of designated air-conditioning duct systems.

8. Activate elevator power shunt trip.

9. Activate emergency lighting control.

10. Activate emergency shutoffs for gas and fuel supplies.

11. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and systems:

1. Valve supervisory switch.

2. Elevator shunt-trip supervision.

3. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of primary power at fire-alarm control unit.

4. Ground or a single break in internal circuits of fire-alarm control unit.

5. Abnormal ac voltage at fire-alarm control unit.


7. Failure of battery charging.

8. Abnormal position of any switch at fire-alarm control unit[or annunciator].

E. System Trouble and Supervisory Signal Actions:

1. Initiate notification appliances.

2. Annunciate at fire-alarm control unit[and remote annunciators].

3. After a time delay of [200 seconds] <Insert time delay>, transmit a trouble or supervisory signal to
the remote alarm receiving station.

2.3 Performance Requirements

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <insert requirement>.

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]."

2.4 Fire-Alarm Control Unit

A. General Requirements for Fire-Alarm Control Unit:

1. Modular, power-limited design with electronic modules, UL 864 listed.
   a. Include a real-time clock for time annotation of events.
   b. The FACP shall be listed for connection to a central-station signaling system service.

B. Alphanumeric Display and System Controls: Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, [one line] [two lines] of [40] [80] characters, minimum.

C. Circuits:

1. No Fewer Than [Five] <insert number> Initiating-Device Circuits:
   a. [Four] <insert number> circuits, NFPA 72, Class B.
   b. [One] <insert number> circuit(s), NFPA 72, Class A.

2. No Fewer Than [Two] <insert number> Notification-Appliance Circuits: NFPA 72, Class B.

3. Pathway Survivability: [Level 0] [Level 1].

4. Serial Interfaces:
   a. One RS 485 port for remote annunciators.
   b. One RS 232 port for personal computer configuration.

D. Notification-Appliance Circuit: Operation shall sound a <insert pattern>.

E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall [be] [not be] connected to fire-alarm system.

F. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

G. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, [supervisory signals] [and] [supervisory and digital alarm communicator transmitters] shall be powered by the 24-V dc source.
1. Alarm current draw of the entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 Manual Fire-Alarm Boxes

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
   2. Double-action mechanism requiring two actions to initiate an alarm, [breaking-glass or plastic-rod] [pull-lever] type.
   3. Station Reset: Key- or wrench-operated switch.

2.6 System Smoke Detectors

A. General Requirements for System Smoke Detectors:
   1. Operating at 24-V dc, nominal.
   2. Detectors shall be [four] [two]-wire type.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type, indicating detector has operated[ and power-on status].
   6. Provide multiple levels of detection sensitivity for each sensor[, with alarm-verification feature].

B. Photoelectric Smoke Detectors: Comply with UL 268.

C. Ionization Smoke Detector: Comply with UL 268.

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Remote indication[ and test] station.[ Operating key switch initiates an alarm test.]
   2. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
   3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
2.7 Carbon Monoxide Detectors

A. Description: Listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Detector shall provide means to test by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Detector shall be listed to comply with UL 2075.
6. Detectors shall be located, mounted, and wired according to manufacturer's written instructions.
7. Test button simulates an alarm condition.

2.8 Nonsystem Smoke Detectors

A. General Requirements for Nonsystem Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac [with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device].
2. Auxiliary Relays: One [Form C, rated at 0.5 A] [Form A and one Form C, both rated at 0.5 A].
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
5. Heat sensor, 135 deg F (57 deg C) [combination rate-of-rise and] fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

10. Integral Visual-Indicating Light: LED type, indicating detector has operated [and power-on status].

C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.

2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.

3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.


2.9 Heat Detectors

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.

1. Mounting: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature.

1. Mounting: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].

2.10 Notification Appliances

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Chimes, High-Level Output: Vibrating type.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Mounting: Wall mounted unless otherwise indicated.

2. Flashing shall be in a temporal pattern, synchronized with other units.


4. Mounting Faceplate: Factory finished, [red] [white].

2.11 Remote Annunciators

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

   1. Mounting: [Flush] [Surface] cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.12 Digital Alarm Communicator Transmitter

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture [one] [two] telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on [either] line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

   1. Zone of the alarm initiating device.
   2. Zone of the supervisory signal.
3. Zone of the trouble initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 Equipment Installation

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

G. Elevator Shafts: Install a heat detector within 24 inches (610 mm) of each sprinkler head. Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in
sprinklered elevator shafts.

H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 Pathways

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.3 Connections

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Connect supervised interface devices to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.

2. Magnetically held-open doors.

3. Electronically locked doors and access gates.

4. Supervisory connections at valve supervisory switches.

5. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
6. Supervisory connections at fire-pump engine control panel.

7. <Insert connections>.

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. Install framed instructions in a location visible from fire-alarm control unit.

3.5 Grounding

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 Field Quality Control

A. Field tests shall be witnessed by [Architect] [authorities having jurisdiction] <Insert names or titles of witnesses>.

B. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:

1. Visual Inspection: Conduct the visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in Chapter 10 "Fundamentals," Section 10.18.21 "Completion Documents, Preparation."
   b. Comply with NFPA 72, Chapter 14, "Inspection, Testing, and Maintenance," Section 14.3 "Inspection" and the "Visual Inspection Frequencies" Table; retain the "Initial/Reacceptance" column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test visible appliances for the public operating mode according to manufacturer's written instructions.

5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced...
devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with the visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 Demonstration

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 12