

PROJECT MANUAL / SPECIFICATIONS

Document Issue Date: December 1st, 2017

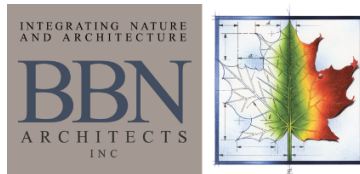
USD 320 Wamego- Phase 2, Bid Package 3, Wamego Middle School Science Addition

Location of Project: 1701 Kaw Valley Rd., Wamego, KS 66547

Owner: USD 320 Wamego, 1008 8th St., Wamego, KS 66547

Architect: BBN Architects Inc., 228 Poyntz Avenue, Manhattan, KS 66502

CMAR: Coonrod & Associates Construction Co., Inc., 3550 S. Hoover Rd., Wichita, KS,
67215



**USD 320 Wamego- Phase 2, Bid
Package 3- Wamego Middle School
Science Addition**

INSTRUCTIONS TO BIDDERS

Date: 12/1/2017

Construction Manager:	Brad Rice, Project Manager Scot Wolfington, Project Lead Steve Austin- Superintendent	Coonrod & Associates Coonrod & Associates Coonrod & Associates	bradr@coonrod.com	P: 316-942-8430
Architect:	Dan Crouch Carl Riblett	BBN Architects Inc. BBN Architects Inc.		

USD 320 Wamego- Phase 2, Bid Package 3- Wamego Middle School Science Addition	Bid Date	Time
	<u>12/21/2017</u>	<u>2:00:00 PM, CST</u>

Bidding Procedures Public bid opening

Bids can be turned in at: **USD 320 District Office, 1008 8th St., Wamego, KS,
66547 at the PLC Room**

Faxed Bids are acceptable. Please send to the fax number **785-456-1690**

Emailed bids are acceptable. Please email to **bids@coonrod.com**.

FAXED OR EMAILED BIDS MUST RECEIVE EMAIL ACKNOWLEDGEMENT OF RECEIPT.

The owner, architect and construction manager will review the bids and determine the lowest, responsible bidder. The owner, architect and/or the construction manager reserve the right to reject any and/or all bids.

Late bids will not be considered.

Please use bid form provided.

There will be a bid scope sheet issued via addendum. Please review and bid accordingly.

Plans

www.gradebeam.com

Coonrod & Associates Main Office (3350 S. Hoover Rd., Wichita)

- Available for viewing in office only

<http://www.coonrod.com/wamego/>

Kansas Construction News Report- Wichita, KS

****Addenda only sent to bidders receiving plans from Gradebeam**

Bonding

Successful subcontract bidders over \$100,000 require Perf. & Payment Bonds

Include the price of the bid bond and P&P bond in the bid

BID BOND IS NOT REQUIRED.

Sales Tax

Exempt

Alternates:

None- Unless added by Addendum.

Unit Prices:

See specification section 012200 for Unit Prices 1, 2 and 3.

Schedule

Schedule will be issued via addendum.

Liquidated damages = \$500 / calendar day past substantial completion.

SUBSTANTIAL COMPLETION IS August 1st, 2018.

Testing & Special Inspections

Per specific specification section requirements.

Submittals

Via Submittal Exchange

Misc. Items

1. ALL questions/RFI's pre-bid and during construction must be sent in writing. Please send to bradr@coonrod.com.

2. All subs/suppliers are responsible for having material delivered on time and have crews ready to go per the CM's schedule. There will be no added compensation for overtime work only unless there are circumstances out of the subcontractor's/supplier's control.

Each subcontractor is required to provide enough manpower to meet the schedule and your bid should reflect this accordingly.

Each subcontractor / supplier is to make sure that materials can and will arrive on time per the schedule BEFORE BIDDING. **There will be no added compensation after the bid**

for accelerating the delivery time.

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SECTION 00 26 00 - PROCUREMENT SUBSTITUTION PROCEDURES**1.1 DEFINITIONS**

- A. Procurement Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Procurement and Contracting Documents, submitted prior to receipt of bids.
- B. Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Contract Documents, submitted following Contract award. See Section 01 25 00 "Substitution Procedures" for conditions under which Substitution requests will be considered following Contract award.

1.2 QUALITY ASSURANCE

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

1.3 PROCUREMENT SUBSTITUTIONS

- A. Procurement Substitutions, General: By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Procurement Substitution Requests will be received and considered by Owner when the following conditions are satisfied, as determined by Architect; otherwise requests will be returned without action:
 - 1. Extensive revisions to the Contract Documents are not required.
 - 2. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 - 3. The request is fully documented and properly submitted.

1.4 SUBMITTALS

- A. Procurement Substitution Request: Submit to Architect. Procurement Substitution Request must be made in writing by prime contract Bidder only in compliance with the following requirements:
 - 1. Requests for substitution of materials and equipment will be considered if received no later than 10 days prior to date of bid opening.
 - 2. Submittal Format: Submit three copies of each written Procurement Substitution Request, using form bound in Project Manual after Section 01 25 00 "Substitution Procedures."

- a. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specifications Sections and drawing numbers.
- b. Provide complete documentation on both the product specified and the proposed substitute, including the following information as appropriate:
 - 1) Point-by-point comparison of specified and proposed substitute product data, fabrication drawings, and installation procedures.
 - 2) Copies of current, independent third-party test data of salient product or system characteristics.
 - 3) Samples where applicable or when requested by Architect.
 - 4) Detailed comparison of significant qualities of the proposed substitute with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - 5) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - 6) Research reports evidencing compliance with building code in effect for Project, from ICC-ES or from code organization acceptable to Owner.
 - 7) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will become necessary to accommodate the proposed substitute.
- c. Provide certification by manufacturer that the substitute proposed is equal to or superior to that required by the Procurement and Contracting Documents, and that its in-place performance will be equal to or superior to the product or equipment specified in the application indicated.
- d. Bidder, in submitting the Procurement Substitution Request, waives the right to additional payment or an extension of Contract Time because of the failure of the substitute to perform as represented in the Procurement Substitution Request.

B. Architect's Action:

1. Architect may request additional information or documentation necessary for evaluation of the Procurement Substitution Request. Architect will notify all bidders of acceptance of the proposed substitute by means of an Addendum to the Procurement and Contracting Documents.

- C. Architect's approval of a substitute during bidding does not relieve Contractor of the responsibility to submit required shop drawings and to comply with all other requirements of the Contract Documents.

END OF SECTON 00 26 00

SECTION 01 10 00 - SUMMARY**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
1. Project information.
 2. Work covered by Contract Documents.
 3. Access to site.
 4. Coordination with occupants.
 5. Work restrictions.
 6. Specification and drawing conventions.
- B. Related Requirements:
1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: USD 320 Wamego School District Improvements.
1. Project Locations:
 - a. Central Elementary School, 900 7th Street, Wamego, KS 66547
 - b. West Elementary School, 1911 Sixth Street, Wamego, KS 66547
 - c. Wamego Middle School, 1701 Kaw Valley Road, Wamego, KS 66547
 - d. Wamego High School, 801 Lincoln, Wamego, KS 66547
 - e. Wamego Sports Complex-Highway 24 and Columbian Rd.
 - f. Wamego Facilities and Bus Operations, 4290 Columbian Rd.
 - g. District Office
- B. Owner: USD 320 Wamego School District, 1008 8th Street, Wamego, KS 66547.
1. Representative: Tim Winter, Superintendent.
- C. Architect: BBN Architects Inc., 228 Poyntz Avenue, Manhattan, KS 66502.
1. Representative: Dan Crouch; dlc@bbnarchitects.com

- D. Construction Manager at Risk: Coonrod and Associates Construction Company, Inc., 3550 S Hoover Rd, Wichita, KS 67215.
1. Representative: Brad Rice.
 2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
1. Renovation of existing facilities and construction of construction of new facilities.
- B. Type of Contract: Project will be constructed under a single contract with the Construction Manager at Risk.

1.5 ACCESS TO SITE

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

1.6 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.

2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.7 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise indicated.
 1. Weekend Hours: 7:00 a.m. to 5:00 p.m., with Owner's written permission.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 1. Notify Owner not less than two days in advance of proposed utility interruptions indicating specific times of the interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 1. Notify Owner not less than two days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Restricted Substances: Use of tobacco products and other controlled substances within the existing building or on Project site is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 22 00 - UNIT PRICES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 01 26 00 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 2. Section 01 40 00 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)**PART 3 - EXECUTION****3.1 SCHEDULE OF UNIT PRICES (EXAMPLES)**

- A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.
1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 31 20 00 "Earth Moving."
 2. Unit of Measurement: **Cubic yard (Cubic meter)** of soil excavated, based on in-place surveys of volume before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 01 21 00 "Allowances."
- B. Unit Price No. 2: Rock excavation and replacement with satisfactory soil material.
1. Description: Classified rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 31 20 00 "Earth Moving."
 2. Unit of Measurement: **Cubic yard (Cubic meter)** of rock excavated, based on survey of in-place surveys volume of before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 01 21 00 "Allowances."
- C. Unit Price No. 3: Cutting and patching of concrete slabs-on-grade.
1. Description: Cutting of new or existing concrete slabs-on-grade up to [**6 inches (152 mm)**] **<Insert dimension>** thick, removal and excavation as required, and subsequent backfill, compaction, and patching of concrete according to Section 01 73 00 "Execution." not otherwise indicated in the Contract Documents.
 2. Unit of Measurement: **Square feet (Square meters)** of concrete removed.

END OF SECTION 01 22 00

SECTION 01 23 00 - ALTERNATES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

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

1.3 DEFINITIONS

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

1.4 PROCEDURES

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Provide new locker installations.

Phase 1, BP
1- WMS
Locker
Replacement

1. Base Bid: Furnish and install new lockers to replace existing lockers as indicated on Drawings A101 through A106 and as specified in Section 10 51 13 "Metal Lockers."
2. Alternate: Furnish and install "Added" lockers in new locations as indicated on Drawing A103, Floor Plan Area C-1 and as specified in Section 10 51 13 "Metal Lockers."

END OF SECTION 01 23 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Request for Substitution Form (RFS): Use facsimile of form following this Section.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section.

Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 10 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

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

1.6 PROCEDURES

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

PART 2 - PRODUCTS**2.1 SUBSTITUTIONS**

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

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Request for Substitution (RFS)

USD 320 Wamego School District Improvements Project Name

RFS No: _____
Date Issued: _____

Project Name: USD 320 Wamego School
District Improvement **Issued by:** _____
BBN Project No: _____ **Copies:** _____

Product, Material or Equipment Required of the Contract Documents:

Specification Section: _____ Drawing No./Detail: _____
Description: _____

Requested Substitute Product, Material or Equipment:

Description: _____
Manufacturer: _____ Trade Name: _____
Model Number: _____ Installer: _____

Attachments Included: Drawings Product Data Samples
 Test Reports Comparative Data

Reason for Substitution: _____

Has this item been used in a similar application? Yes No

Description: _____
Date Installed: _____
Owner Contact: _____

Comparisons of the Specified Item and the Proposed Substitution:

Compliance with specified quality, size, weight, durability, performance and visual appearance:
Describe any changes required in other elements of the Work:
Describe any changes of the Work required by the Owner, separate Contractors, or Consultants:
Verify all specified warranties, code and accessibility compliance, sustainability, and other requirements are met:
What affect with and without approval of the proposed substitution will there be on the Work Schedule:

Project Name: USD 320 Wamego School District
Improvements

RFS No: _____

Provide detailed breakdown of the cost comparison of the required item to the proposed substitution, including modifications required to other Work:

Proposed Substitution Summary:

Net Cost to the Owner:

Change in Contract Time:

Signatures:

Permission to make any substitution after Award of Contract shall be effected by Change Order (CO). CO shall not relieve the Contractor, any subcontractor, or manufacturer, fabricator, or supplier from the responsibility for any deficiency that may exist in the substituted product or any departures or deviations from the Contract Documents as modified by such CO. Except as otherwise expressly specified by the Contractor in the Request for Substitution (RFS) and expressly approved in such CO, the Contractor shall be deemed to warrant, by his request, that the proposed substitute will satisfy all standards and requirements satisfied by the original product, material or equipment specified and the CO shall not be deemed to modify the Contract Documents with respect thereto. If any substitution will affect a correlated function, adjacent construction, or the work of other trades or contractors, the necessary changes and modifications to the affected work shall be considered as an essential part of the proposed substitution, to be accomplished by the Contractor without additional expense to the Owner if and when accepted. The Contractor shall be deemed to warrant the Net Cost to the Owner and Change in Contract Time stated in this RFS are complete, and claims for additional Cost or Time related to the substitution which may become subsequently apparent are waived.

Contractor's Signature: _____ **Date:** _____

Response:

- | | |
|-------------|--|
| RFS Action: | <input type="checkbox"/> Approved |
| | <input type="checkbox"/> Make Corrections Noted |
| | <input type="checkbox"/> Revise as Noted and Resubmit |
| | <input type="checkbox"/> Rejected, Resubmit Specified Item |
| | <input type="checkbox"/> Action Not Taken |
| | <input type="checkbox"/> More Information Required |

RFS Response by: _____ **Date:** _____

BBN Architects, Inc.

BBN Architects, Inc. **Contractor:** _____ **Owner:** _____

Accepted By: _____ **Accepted By:** _____ **Accepted By:** _____

Date: _____ **Date:** _____ **Date:** _____

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 01 22 00 "Unit Prices" for administrative requirements governing the use of unit prices.
 - 2. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 3. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

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

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedules.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect through Construction Manager at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one-line item for each Specification Section.
1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Arrange schedule of values consistent with format of AIA Document G703.
 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - a. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
 5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
 7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

8. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
9. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
10. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
11. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and Construction Manager and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment-Application Times: The date for each progress payment is the last day of each month or as otherwise indicated in the Contract Agreement. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days prior to the date for each progress payment.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Construction Manager will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

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

12. Copies of building permits.
 13. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 14. Initial progress report.
 15. Report of preconstruction conference.
 16. Certificates of insurance and insurance policies.
 17. Performance and payment bonds.
 18. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 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.
 9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

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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.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project meetings.
 - 5. Digital project management procedures.
- B. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each principal portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.

- B. Digital Coordination Drawings: Two-dimensional documents, such as schedules, shop drawings, product data, and general information, shall be submitted electronically in portable document format (PDF) file.
- C. Key Personnel Names: Within five days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

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

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

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Provide coordinated composite drawings, drawn at a scale not less than 1/4 inch per foot in both plan and elevation, including, but not limited to, equipment, ducts, pipe sleeves, piping including plumbing and sprinkler systems, lighting, special supports and other items contained within the space and finished ceiling. Show mechanical and electrical services and architectural and structural features drawn to scale. Provide composite drawings for corridors, specialty spaces, electrical rooms, communication rooms, mechanical rooms, shafts, tunnels, and other areas of limited space with complex systems. Distribute copies of composite drawings to all trades to assure a complete, coordinated installation of work within the space available. Include elevation drawings indicating finish ceiling heights, and heights above finished floor to bottom of ductwork, piping, conduit and other overhead fixtures and equipment.
 - 1) Sheet Size: At least 8-1/2-by-11-inch (215-by-280-mm) paper but no larger than 30 by 40 inches (760 by 1016 mm).
 - 2) Draw required details at a scale not less than 3/4 inch per foot.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - 1) Scheduling, sequencing movement, and positioning of large equipment into the building during construction.

- g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - h. Refer to Sections of Division 23 and Division 26 for specific Coordination Drawing requirements for mechanical and electrical installations.
 - i. Indicate relationship of components shown on separate Shop Drawings.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work. Designate fire-rated walls, partitions and floors.
 2. Mechanical and Electrical Rooms: Provide coordination drawings for mechanical and electrical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 3. Through Penetrations: Indicate fire-rated and non-fire-rated penetrations and openings required for all disciplines through interior and exterior walls, interior partitions, foundation walls, and floor slabs.
 4. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 5. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, supply piping, sanitary, floor and roof drain piping, and conduit runs, including insulation, bracing, flanges, and support systems. Indicate access points and required maintenance areas.
 - b. Dimensions of major components, such as control boxes, dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 6. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, electrified door hardware, access controls, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 7. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 8. Site Work: Show the following:

- a. Civil and electrical underground utilities, both new and existing.
 - b. Location of all building/site ground connections/rods.
9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using Portable Data File (PDF) format.

1.7 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified using the Submittal Exchange.
1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect and Construction Manager.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect or AIA Document G716.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's and Construction Manager's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect or Construction Manager after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly, with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect and Construction Manager.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
- F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within seven Insert number days if Contractor disagrees with response.
1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Web-Based Project Software: Use Construction Manager's web-based Project software site, "Submittal Exchange," for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project software site includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 2. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

- A. General: Construction Manager will schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Architect, within three days of the meeting.
- B. Preconstruction Conference: Construction Manager will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long-lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Procedures for processing field decisions and Change Orders.
 - h. Procedures for RFIs.
 - i. Procedures for testing and inspecting.
 - j. Procedures for processing Applications for Payment.
 - k. Distribution of the Contract Documents.
 - l. Submittal procedures.
 - m. Preparation of record documents.
 - n. Use of the premises and existing building.
 - o. Work restrictions.
 - p. Working hours.
 - q. Owner's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Demolition and construction waste management.
 - v. Parking availability.
 - w. Office, work, and storage areas.
 - x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Schedule and conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - 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.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Construction Manager will schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

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

- 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Construction Manager will conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Sequence of finish installation.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.

- 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of correction of deficient items.
 - 15) Field observations.
 - 16) Requests for interpretations (RFIs).
 - 17) Status of Proposal Requests (PRs).
 - 18) Pending changes.
 - 19) Status of Change Orders.
 - 20) Pending claims and disputes.
 - 21) Documentation of information for payment requests.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

- 1. Initial construction schedule.
- 2. Contractor's construction schedule.
- 3. Construction schedule updating reports.
- 4. Daily construction reports.
- 5. Material location reports.
- 6. Site condition reports.
- 7. Special reports.

- B. Related Requirements:

- 1. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports and for electronic submittal requirements.
- 2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.
- B. Initial construction schedule.
 - 1. Approval of cost-loaded, initial construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Initial Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.

4. Earnings Report: Compilation of Contractor's total earnings from Notice to Proceed until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.
- H. Material Location Reports: Submit at weekly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Special Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Discuss constraints, including phasing, area separations, interim milestones, and partial Owner occupancy.
 4. Review delivery dates for Owner-furnished products.
 5. Review schedule for work of Owner's separate contracts.
 6. Review submittal requirements and procedures.
 7. Review time required for review of submittals and resubmittals.
 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 10. Review and finalize list of construction activities to be included in schedule.
 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from entities involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. Elevators.
 - b. Structural steel.
 - c. Modular bathrooms
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 1. Phasing: Arrange list of activities on schedule by phase.
 2. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 3. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.

- d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
4. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
- a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
5. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
- a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion, and the following interim milestones:
1. Temporary enclosure and space conditioning.
 2. Completion of East Assisted Living Addition (Building A).
 3. Completion of Assisted Living Renovation and Addition (Building B).
 4. Completion of Community Space Upgrades (Building C).
 5. Completion of Independent Living Renovation and Elevator Addition (Building D).
 6. Completion of Specialty Care Assisted Living Facility (SCALF) Renovation (Building J).
 7. Completion of Short Term Stay Building (Building K)
 8. Completion of Long Term Care (LTC) Stand Alone (Building L).
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
1. See Section 01 29 00 "Payment Procedures" for cost reporting and payment procedures.

- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2.2 INITIAL CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit initial, horizontal, bar-chart-type construction schedule within 15 days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Initial Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's construction schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice to Proceed.
 - a. 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 Architect's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the initial network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and commissioning.
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.4 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.

4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.5 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION**3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE**

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

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 Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 01 31 00 "Project Management and Coordination" for submittal requirements using "Submittal Exchange."
 - 2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 3. Section 01 60 00 "Product Requirements" for administrative and procedural requirements for selection of products for use in Project.
 - 4. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 5. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 6. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal: Submit concurrently with initial construction schedule but prior to first application for payment. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Six-Week Look-Ahead Schedules: Maintain and update submittal schedules to reflect current conditions at the project site and project status. Submit revised submittal schedules highlighting the submittals planned in the subsequent six weeks.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's and Construction Manager's final release or approval.
 - g. Scheduled date of fabrication.
 - h. Scheduled dates for purchasing.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Electronic Data: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals upon execution of AIA Document C106, Digital Data Licensing Agreement.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submittal items required for each Specification Section shall be submitted concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 5. Arrange for preparation of required submittals in sufficient detail to permit analysis and review by Architect and Construction Manager, sufficiently early to allow for review, and accommodate the rate of construction progress required under the Contract. Delete or mark out extraneous material not relevant to the Project.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on the first full working day following Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 10 consecutive working days for initial review of each submittal. processing must be delayed to permit coordination with subsequent submittals or if concurrent review is required. Construction Manager will advise Contractor when a submittal being processed must be delayed for coordination or concurrent review.
 2. Resubmittal Review: Allow 10 consecutive working days for review of each resubmittal.
 3. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 15 consecutive working days for initial review of each submittal.
 4. Concurrent Consultant Review: Where concurrent review of submittals by Architect's consultants, Owner, or other parties is required, allow 15 working days for initial review of each submittal. Submittal will be returned to Construction Manager, through Architect, before being returned to Contractor.
 - a. Submit to concurrent reviewer, Architect, and Construction Manager.
 5. Extended Review: Allow 20 consecutive working days for initial review of the following submittals:
 - a. Coordination drawings.
 - b. Windows.
 - c. Door hardware.
 - d. Electronic security systems.
 - e. HVAC temperature controls.
 - f. HVAC balancing report.
 - g. If more than five shop drawings of a single trade are received in one week.
- D. Electronic Submittals: Two-dimensional documents, such as schedules, shop drawings, product data, and general information, shall be submitted electronically in portable document format (PDF) file. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name and address of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number, numbered consecutively.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect and Construction Manager on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Resubmittals: Make resubmittals in same form as initial submittal.

1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's and Construction Manager's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's and Construction Manager's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website, "Submittal Exchange." Enter required data in web-based software site to fully identify submittal.
 - a. Architect, through Construction Manager, will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

2.2 ACTION SUBMITTALS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are 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. Delete or mark out extraneous material that is not applicable to the Work. Edit material to conform to project requirements, and to clearly show model number, type and size

- proposed. Provide additional information as necessary to supplement standard information.
3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's written recommendations.
 - d. Standard color charts.
 - e. Statement of compliance with specified referenced standards.
 - f. Testing by recognized testing agency.
 - g. Application of testing agency labels and seals.
 - h. Notation of coordination requirements.
 - i. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Mill reports.
 - e. Standard product operating and maintenance manuals.
 - f. Compliance with recognized trade association standards.
 - g. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - 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. Shop fabrication instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 - m. Relationship and attachment to adjoining construction clearly indicated.
 - n. Seal and signature of professional engineer if specified.

- o. Highlight deviations from the Contract Documents.
2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).
4. Do not use Shop Drawings for ordering, fabrication, or construction without an appropriate final stamp from the Construction Manager and Architect indicating action taken in connection with construction.
5. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- C. Samples: Submit Samples for review of size, kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
 1. Samples are required only for comparable products, substitutions, and custom fabricated items, unless samples are specifically required by the individual Sections.
 - a. Samples are not required and will not be reviewed if a specified item is being provided.
 - b. Samples are required and action will be taken if the specified item is no longer available, the manufacturer's current catalog numbers vary from those specified, named manufacturer's product data differs from requirements, or where custom colors require evaluation.
 2. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 3. Mount, or display, Samples to facilitate review of qualities specified. Prepare Samples to match the Architect's sample. Include the following identification label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number, submittal number, and generic name of each item.
 - f. Compliance with recognized standards.
 - g. Availability and delivery time.
 4. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
6. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
- a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect, through Construction Manager, will return submittal with options selected.
7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- a. Number of Samples: Submit three sets of Samples. Architect and Construction Manager will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

2.3 INFORMATIONAL SUBMITTALS

- A. Contractor's Submittal Schedule: Comply with requirements specified in this Section under SUBMITTAL ADMINISTRATIVE REQUIREMENTS.
- B. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- C. Insurance Certificates and Bonds: 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.
- D. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."

- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- F. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- G. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- I. Project Record Documents: Comply with requirements specified in Section 01 78 39, "Project Record Documents."
- J. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- L. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- P. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

- Q. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- R. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- S. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- T. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- U. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- V. Design Data: Prepare and submit 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.

2.4 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic calculation files, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

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

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and Construction Manager.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 1. Architect and Construction Manager will take no action on submittals that have not been stamped and certified.

3.2 ARCHITECT'S AND CONSTRUCTION MANAGER'S ACTION

- A. Action Submittals: Architect and Construction Manager will review each submittal, make marks to indicate corrections or revisions required, and return it. The review is for general conformance with the design concept and the information given in the construction documents. Corrections or comments made on the shop drawings/submittal during this review do not relieve Contractor from compliance with the requirements of the plans and specifications. Review of the specific item shall not include review of an assembly of which the item is a component. The contractor is responsible for: dimension to be confirmed and correlated at the job site; information that pertains solely to the fabrication processes or the means, methods, techniques, sequences and procedures of construction; coordination of the work with that of all other trades and performing all work in a safe and satisfactory manner.
- B. Construction Manager will stamp each submittal with an action stamp indicating review of submittal before forwarding to Architect.
- C. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
 1. **"No Exceptions Taken"** - When the Architect marks a submittal "No Exceptions Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 2. **"Make Corrections Noted"** - When the Architect marks a submittal "Make Corrections Noted," the Work covered by the submittal may proceed provided it complies with

- notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
3. **"Revise and Resubmit"** - When the Architect marks a submittal "Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
 4. **"Rejected"** - When the Architect marks a submittal "Rejected," do not proceed with Work covered by the submittal. The Work covered by the submittal does not conform to the design concept or meet Contract Document requirements.
 - a. Do not use, or allow others to use, submittals marked "Rejected – Submit Specified Item" at the Project Site or elsewhere where Work is in progress.
 5. **"Submit Specified Item"** - When the Architect marks a submittal "Submit Specified Item," do not proceed with Work covered by the submittal. The Work covered by the submittal does not conform to the design concept or meet Contract Document requirements. Prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Rejected – Submit Specified Item" at the Project Site or elsewhere where Work is in progress.
 6. **"Action Not Taken"** - Where a submittal is for information or record purposes or special processing or other activity, the Architect will return the submittal marked "Action Not Taken."
- D. Informational Submittals: Architect and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
- E. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- F. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- G. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. 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.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.3 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 or Construction Manager.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. Benchmarks: Samples that serve as standards by which other work may be measured or judged.

1. Approved benchmark samples shall use full scale, on-site surface areas and spaces. These shall be prepared using the complete specified or approved paint, coating, or decorative system. The sample shall include complete systems.
 2. Benchmark samples for interior coating systems shall be prepared only after permanent lighting, heating, venting and air conditioning equipment have been installed and activated.
 3. The condition of the surface to be used as the sample area shall be acceptable to the Architect prior to the preparation of the benchmark sample.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., 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: An 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. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- K. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

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

appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

- C. Items indicated on the drawings but not included in the specifications, or included in the specifications and not indicated on the drawings, shall have the same effect as if indicated or included in both. In case of conflict or inconsistency between the drawings and the specifications, the Contractor shall additional information or interpretation as specified in Section 01 31 00 "Project Management and Coordination." Any adjustment by the Contractor without such determination shall be at its own risk and expense.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Qualification Data: For Contractor-engaged testing agencies to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.6 INFORMATIONAL SUBMITTALS

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

- E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 15 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 - 3. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare certified written reports specified in other Sections. 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.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade jurisdiction settlements and similar conventions.
- G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

- c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.
2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect or Construction Manager.
 2. Notify Architect or Construction Manager seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Architect's and Construction Manager's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed unless otherwise indicated.
- K. Benchmarks: Benchmark samples shall be prepared to establish full scale, on-site surfaces to serve as standards by which subsequent work may be measured or judged. Each sample shall be prepared using the complete specified products, materials, or systems.

1.10 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Testing Agency Responsibilities: Cooperate with Architect, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

- G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and 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.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated on Sheet S201 of the Structural Drawings, and as follows:
1. Information for the proposed special inspections firm shall be submitted to the Owner, Architect, and Structural Engineer for approval.
 2. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 3. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 4. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, with copy to Contractor and to authorities having jurisdiction.
 5. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 6. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 7. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)**PART 3 - EXECUTION****3.1 TEST AND INSPECTION LOG**

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

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 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. General: Basic Contract definitions are included in the General Conditions of the Contract for Construction.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
 - 1. "Installer": Entity engaged by the Contractor, either as an employee or subcontractor, to perform an "Install" construction activity.
 - a. Installer shall be experienced in the operations they are engaged to perform.
 - 2. "Experienced Installer": Entity that has successfully completed a minimum of five previous projects similar in size and scope to this Project; is familiar with the special requirements indicated; and has complied with requirements of authorities having jurisdiction.
- H. "Provide": Furnish and install, complete and ready for the intended use.

- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

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

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Materials, equipment, and operations specified by reference to published standards and specifications of a technical society, trade association, or other agency standard, shall comply with the requirements of the current edition of the listed document that is in effect on the issue date of the Specifications or Addendum page making reference thereto, unless otherwise specified. Make available at site, copies of referenced documents as Owner's Representative or Architect may request.
 1. No Provision of a reference standard, specification, manual, or code shall be effective to change the duties and responsibilities of the Owner, the Contractor, the Architect and their consultants, their agents and employees from those duties and responsibilities set forth in the Contract Documents.
- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
 1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 2. ICC - International Code Council; www.iccsafe.org.
 3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

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

1. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
3. DOD - Department of Defense; www.quicksearch.dla.mil.
4. DOE - Department of Energy; www.energy.gov.
5. EPA - Environmental Protection Agency; www.epa.gov.
6. FG - Federal Government Publications; www.gpo.gov.
7. HUD - Department of Housing and Urban Development; www.hud.gov.
8. OSHA - Occupational Safety & Health Administration; www.osha.gov.
9. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
10. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
11. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
12. USPS - United States Postal Service; www.usps.com.

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

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

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

1. ADPH: Alabama Department of Public Health

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.

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

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

1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

- D. **Moisture-Protection Plan:** Describe procedures and controls for protecting materials and construction from water absorption and damage.
1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
- E. **Dust- and HVAC-Control Plan:** Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
1. Locations of dust-control partitions at each phase of work.
 2. HVAC system isolation schematic drawing.
 3. Location of proposed air-filtration system discharge.
 4. Waste-handling procedures.
 5. Other dust-control measures.

1.5 QUALITY ASSURANCE

- A. **Electric Service:** Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. **Tests and Inspections:** Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. **Accessible Temporary Egress:** Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. **Chain-Link Fencing:** Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails.

- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- C. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches (914 by 1624 mm).
- D. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures".
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
 1. Water Service: Access to Owner's existing water service facilities may be allowed at the discretion of the Owner. Water service facilities shall be cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, these facilities shall be restored to condition existing before initial use.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 1. Toilets: Use of Owner's existing toilet facilities may be permitted at the discretion of the Owner. If permitted, facilities shall be cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, these facilities shall be restored to condition existing before initial use.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. Electric Power Service: Connect to Owner's existing electric power service provided the service is of sufficient size, capacity, and power characteristic required for construction operations. Maintain equipment in a condition acceptable to Owner.
1. If required, install electric power service overhead unless otherwise indicated.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- J. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.

2. Prepare subgrade and install subbase and base for temporary roads and paved areas as indicated on the Drawings.
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 3. Maintain and touchup signs so they are legible at all times.
- F. Waste Disposal Facilities: Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."
- G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
1. Comply with work restrictions specified in Section 01 10 00 "Summary."
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
1. Extent of Fence: As indicated on Drawings.
 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- L. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 2. Construct dustproof partitions with two layers of 6-mil (0.14-mm) polyethylene sheet on each side. Cover floor with two layers of 6-mil (0.14-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air-handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

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

2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary office spaces, enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. At Substantial Completion, restore Owner-allocated office spaces to condition existing before initial use,
 2. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
 - 1. Where applicable, materials and construction shall be in accordance with the City of Edmond Standard Specifications for Construction (Standard Specifications) and Construction Standards.
- B. Related Requirements:
 - 1. Section 01 42 00 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
- B. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products or equipment which will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on accessible, but inconspicuous, surface in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.
 7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
- B. Provide materials and equipment that are of good quality and new, unless otherwise specified, are free from faults and defects not inherent in the quality required, that conform with requirements of Contract Documents, that are suitable for use and function intended, that are corresponding in quality to related materials in the absence of a complete specification, that are of quality appearance where exposed to view, that are of one manufacturer or source for the same specific purpose, with uniform appearance and physical properties, and that are identical and interchangeable when required in quantity
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. The Architect is solely responsible for evaluation of products and manufacturers submitted as "Or equal" to the specified product or manufacturer.
 - b. Submit additional documentation required by Architect through Construction Manager in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect, whose determination is final.
- C. Product Selection Procedures:
1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements.
 - 1) Comparable products will be considered unless otherwise indicated.
 - 2) Substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 - 1) Comparable products will be considered unless otherwise indicated.
 - 2) Substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- D. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

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

2.2 COMPARABLE PRODUCTS

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for limits on use of Project site.
 - 2. Section 01 31 00 "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 3. Section 01 33 00 "Submittal Procedures" for submitting surveys.
 - 4. Section 01 74 49 "Construction Waste Management and Disposal" for administrative and procedural requirements for disposal and salvaging of nonhazardous demolition and construction waste.
 - 5. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- C. Certified Surveys: Submit two copies signed by land surveyor.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. General: Comply with requirements specified in other Sections.
 - 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

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

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

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, reference points, stakes, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect or Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and Construction Manager before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Except where more stringent requirements are specified, prepare, install, test, adjust and clean products, materials and equipment in accordance with manufacturer's printed instructions, recommendations and limitations for conditions indicated. Provide recommended accessory materials for a complete installation. If conflict exists between job conditions or specified requirements and with manufacturer's instructions, request written clarification from Architect before proceeding.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Coordination of Space: Where space is limited, install components and systems to maximize space available for maintenance and ease of removal for replacement.
- F. Concealed Work: In finished areas, except as otherwise indicated, conceal pipes, ducts, conduit and wiring in the finished construction. Coordinate locations of fixtures, outlets, access panels, and similar items with finish elements. Provide escutcheon plates at penetrations through finished walls, ceilings and floors, with finish appropriate to adjacent finished surface.
- G. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- H. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- I. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

- J. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- K. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- L. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 49 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious

exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Excessive winds.
5. Thermal shock.
6. Excessively high or low humidity.
7. Pollution and air contamination.
8. Water or ice.
9. Chemicals and solvents.
10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining, and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.
29. Theft or vandalism.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Owner reserves the right to protect installed Work to prevent damage and deterioration if the Contractor fails to protect the installed Work in a proper manner. The costs incurred by the Owner shall be paid by the Contractor.

END OF SECTION 01 73 00

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

1.3 DEFINITIONS

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

1.4 MATERIALS OWNERSHIP

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

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for the Notice of Award.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in tons (tonnes).
 - 4. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
- B. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- C. Qualification Data: For waste management coordinator.
- D. 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.
- E. Refrigerant Recovery: Comply with requirements in Section 02 41 19 "Selective Demolition" for refrigerant recovery submittals.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- B. Preconstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Section 02 41 19 "Selective Demolition."
 - 2. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. General: Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate salvage of materials.

PART 3 - EXECUTION**3.1 PLAN IMPLEMENTATION**

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Construction Manager's Superintendent will coordinate implementation, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged.
 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 02 41 19 "Selective Demolition" for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until installation.
 4. Protect items from damage during transport and storage.
 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.

- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 DISPOSAL OF WASTE

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

END OF SECTION 01 74 19

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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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for administrative submittal requirements and electronic submittal requirements.
 - 2. Section 01 73 00 "Execution" for progress cleaning of Project site.
 - 3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 5. Section 01 79 00 "Demonstration and Training" for requirements for instructing Owner's personnel.
 - 6. Sections of Divisions 21 through 28 for specific closeout requirements relate to mechanical, electrical and plumbing systems.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.

- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Construction Manager's signature for receipt of submittals.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 working days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of Punch List items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.
- E. Architect's Inspection for Substantial Completion: Except with the consent of the Owner, the Architect will perform no more than 2 inspections to determine whether the Work or a designated portion thereof has attained Substantial Completion in accordance with the Contract Documents.
1. The Owner will be entitled to deduct from the Contract Sum amounts paid to the Architect for any additional inspections.
 - a. Cost of the Architect's additional services will be calculated in accordance with the hourly rates included in the Agreement between Owner and Architect.
 - b. Architect will issue a deduct Change Order in the amount of Architect's additional services.
 - c. Owner will deduct the amount of Architect's additional services from final payment to Contractor.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment.
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (Punch List), endorsed

- and dated by Architect. Final version of the Punch List shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 working days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A or a form acceptable to the Architect.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect and Construction Manager .
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. PDF electronic file. Architect, through Construction Manager, will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 working days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

- C. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 - 1. Designate specific warranties that will be included in operation and maintenance manuals
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

- h. Sweep concrete floors broom clean in unoccupied spaces.
- i. Clean ceramic tile walls and floors.
- j. Clean, buff and wax resilient floors.
- k. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
- l. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
- m. Remove labels that are not permanent.
- n. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- o. Clean plumbing fixtures, accessories, and trim to a sanitary condition, free of stains, including stains resulting from water exposure.
- p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- q. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
- r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- s. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements established by Construction Manager.

D. Pest Control: Comply with pest control requirements established by Construction Manager. Prepare written report.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

- a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

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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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

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

1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit electronic draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 working days before commencing demonstration and training. Architect will return copy with comments.
 1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 working days of receipt of Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
 1. List of documents.
 2. List of systems.
 3. List of equipment.
 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

2.3 EMERGENCY MANUALS

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

2.4 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:

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

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

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

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

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

2.5 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. Manufacturers' Data: 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 include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared record Drawings in Section 01 78 39 "Project Record Documents."

- G. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for electronic submittal requirements.
 - 2. Section 01 73 00 "Execution" for final property survey.
 - 3. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
 - 4. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 5. Sections in Divisions 02 through 49 for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Submit PDF electronic files of scanned record documents to the Owner. Include all documents, whether changes were made or not.
 - a. Final Submittal: Submit PDF electronic files of scanned record prints, including one set of prints with no changes.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.1 ELECTRONIC DATA

- A. Electronic Data: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals upon execution of AIA Document C106, Digital Data Licensing Agreement.

2.2 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.

- m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file with comment function enabled.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect through Construction Manager for resolution.
 4. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. Architect will provide data file layer information. Record markups in separate layers.
- C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable data file sets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.

- c. Designation "PROJECT RECORD DRAWINGS."
- d. Name of Architect and Construction Manager.
- e. Name of Contractor.

2.3 RECORD SPECIFICATIONS

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

2.4 RECORD PRODUCT DATA

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

2.5 MISCELLANEOUS RECORD SUBMITTALS

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

PART 3 - EXECUTION**3.1 RECORDING AND MAINTENANCE**

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

END OF SECTION 01 78 39

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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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.

- d. Name of Contractor.
 - e. Date of video recording.
2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
 3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
 4. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 1. Inspect and discuss locations and other facilities required for instruction.
 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 3. Review required content of instruction.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

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

PART 2 - PRODUCTS**2.1 INSTRUCTION PROGRAM**

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

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

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

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.
 - 1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
 - 2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
 - 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the

following for each Contractor involved on the Project, arranged according to Project table of contents:

- a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- F. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

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 Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 01 73 00 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse [**store**].
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

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

1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
1. Inspect and discuss condition of construction to be selectively demolished.
 2. Review structural load limitations of existing structure.
 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection , for dust control and , for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 3. Coordination for shutoff, capping, and continuation of utility services.
 4. Use of elevator and stairs.
 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 "Photographic Documentation." Submit before Work begins.
- E. 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.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Universal certified by EPA-approved certification program.

1.9 FIELD CONDITIONS

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

1.10 COORDINATION

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

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

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

PART 3 - EXECUTION**3.1 EXAMINATION**

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

- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

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

- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
 - 1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
 - 2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- C. Cleaning: 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.

3.5 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. 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.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.6 SELECTIVE DEMOLITION, GENERAL

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

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

3.7 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section **<Insert Section number and title>** for new roofing requirements.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.9 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.

3.10 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: <Insert description of items and construction to remove>.
- B. Remove and Salvage: <Insert description of items to remove and salvage>.
- C. Remove and Reinstall: <Insert description of items to remove and reinstall>.
- D. Existing to Remain: <Insert description of items to remain>.
- E. Dismantle: <Insert description of items to be removed>.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
 - 1. Section 03 33 00 "Architectural Concrete" for general building applications of specially finished formed concrete.
 - 2. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-grade.
 - 3. Section 32 13 13 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special concrete finish Subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, vapor-retarder installation,

anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect.
- E. Samples: For waterstops and vapor retarder.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
 - 4. Fiber reinforcement.
 - 5. Waterstops.
 - 6. Curing compounds.
 - 7. Floor and slab treatments.
 - 8. Bonding agents.
 - 9. Adhesives.
 - 10. Vapor retarders.
 - 11. Semirigid joint filler.
 - 12. Joint-filler strips.
 - 13. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.
- E. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
 1. Build panel approximately 100 sq. ft. (9.3 sq. m) for formed surface in the location indicated or, if not indicated, as directed by Architect.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS**2.1 CONCRETE, GENERAL**

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

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
1. Portland Cement: ASTM C 150/C 150M, Type I/II, gray or white as indicated.
 2. Fly Ash: ASTM C 618, Class F or C.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

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

2.6 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Henry Company.
 - d. Sika Greenstreak.
 2. Profile: Ribbed with center bulb.
 3. Dimensions: 9 inches by 3/8 inch thick (225 mm by 10 mm thick); nontapered.
- B. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Henry Company.
 - d. Sika Greenstreak.

2.7 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape; minimum 10 mils thick.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GCP Applied Technologies Inc. (formerly Grace Construction Products).
 - b. Raven Industries, Inc.
 - c. Stego Industries, LLC.
 - d. W. R. Meadows, Inc.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Admixture Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. L&M Construction Chemicals, Inc.
 - d. SpecChem, LLC.
 - e. Vexcon Chemicals Inc.
 - f. W. R. Meadows, Inc.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anti-Hydro International, Inc.
 - b. BASF Corporation; Admixture Systems.
 - c. Euclid Chemical Company (The); an RPM company.
 - d. L&M Construction Chemicals, Inc.
 - e. SpecChem, LLC.
 - f. Vexcon Chemicals Inc.
 - g. W. R. Meadows, Inc.
- F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. BASF Corporation; Admixture Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. L&M Construction Chemicals, Inc.
 - d. SpecChem, LLC.
 - e. Vexcon Chemicals Inc.
 - f. W. R. Meadows, Inc.
- G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. L&M Construction Chemicals, Inc.
 - c. SpecChem, LLC.
 - d. Vexcon Chemicals Inc.
 - e. W. R. Meadows, Inc.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 20 percent or 100 pounds, whichever is less.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS**A. Footings: Normal-weight concrete.**

1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
5. Aggregates shall be proportioned such that mix design shall contain a minimum of 50 percent coarse aggregate per the gradation requirements specified in ASTM C33/C33M.

B. Foundation Walls: Normal-weight concrete.

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
5. Aggregates shall be proportioned such that mix design shall contain a minimum of 50 percent coarse aggregate per the gradation requirements specified in ASTM C33/C33M.

C. Slabs-on-Grade: Normal-weight concrete.

1. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Minimum Cementitious Materials Content: 540 lb/cu. yd. (320 kg/cu. m).
4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
6. Aggregates shall be proportioned such that mix design shall contain a minimum of 50 percent coarse aggregate per the gradation requirements specified in ASTM C33/C33M.

2.13 FABRICATING REINFORCEMENT

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

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION**3.1 FORMWORK INSTALLATION**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

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

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 (ACI 318M) and ACI 301 (ACI 301M) for design, installation, and removal of shoring and reshoring.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR-RETARDER INSTALLATION

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

3.6 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls at maximum 60 feet (18.3 m) on center.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete

when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/4 inch (6.5 mm) or more than 1/2 inch (13 mm) below finished concrete surface where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOP INSTALLATION

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of

concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view.
- C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-

place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 - 3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. **Moisture-Retaining-Cover Curing:** Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
3. **Curing Compound:** Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. **Removal:** After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
4. **Curing and Sealing Compound:** Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

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

- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

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- 7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
 - E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
 - F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor shall engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports as indicated on Sheet S201 of the Project Structural Drawings.
- B. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 hours of finishing.

END OF SECTION 03 30 00

SECTION 03 33 00 - ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place architectural concrete, including form facings, reinforcement and accessories, concrete materials, concrete mixture design, placement procedures, and finishes.
 - 1. Requirements in Section 03 30 00 "Cast-in-Place Concrete" apply to architectural concrete.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for concrete not designated as architectural concrete.

1.3 DEFINITIONS

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

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

- a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Cast-in-place architectural concrete Subcontractor.
2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.
 3. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Formwork Shop Drawings: Show formwork construction, including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
- D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints, including construction joints.
- E. Samples: For each of the following materials:
 1. Form-facing panels.
 2. Form ties.
 3. Form liners.
 4. Exposed aggregates.
 5. Coarse- and fine-aggregate gradations.
 6. Chamfers and rustications.
- F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches (450 by 450 by 50 mm), of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Repair materials.
- C. Material Test Reports: For the following, by a qualified testing agency:
1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
 2. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.
 3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
 4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove field sample panels when directed.

1.8 PRECONSTRUCTION TESTING

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

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS**2.1 CONCRETE, GENERAL**

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301 (ACI 301M).
 2. ACI 303.1.

2.2 FORM-FACING MATERIALS

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for formwork and other form-facing material requirements.
- B. Source Limitations: Obtain each type form-facing material from single source from single manufacturer.
- C. Form-Facing Panels for As-Cast Finishes: Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, high-density overlay, Class 1, or better, complying with DOC PS 1.
- D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that provide surfaces with gradual or abrupt irregularities not exceeding

- specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- F. Rustication Strips: Dressed wood or rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
- G. Chamfer Strips: Dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
- H. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch (6 mm) thick.
- I. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. BASF Corporation; Construction Systems.
- J. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
- K. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 2. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- L. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. BASF Corporation; Construction Systems.
- M. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic, internally disconnecting, or removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 1 inch (25 mm) in diameter on concrete surface.
2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm) from the architectural concrete surface.
3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color selected by Architect from manufacturer's full range.
4. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice."
 1. Where legs of wire bar supports contact forms, use CRSI Class 1, gray, plastic-protected bar supports.

2.4 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 1. Portland Cement: ASTM C 150/C 150M, Type I, gray or white as indicated.
 2. Fly Ash: ASTM C 618, Class C or F.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 5S coarse aggregate or better, graded. Provide aggregates from single source with documented service-record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm).
 2. Gradation: Uniformly graded.
- D. Normal-Weight Fine Aggregate: ASTM C 33/C 33M or ASTM C 144, manufactured or natural sand, from same source for entire Project.
- E. Air-Entraining Admixture: ASTM C 260/C 260M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Euclid Chemical Company (The); an RPM company.

- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that does not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BASF Corporation; Construction Systems.
 - 2) Euclid Chemical Company (The); an RPM company.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BASF Corporation; Construction Systems.
 - 2) Euclid Chemical Company (The); an RPM company.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BASF Corporation; Construction Systems.
 - 2) Euclid Chemical Company (The); an RPM company.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BASF Corporation; Construction Systems.
 - 2) Euclid Chemical Company (The); an RPM company.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
- G. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Admixture Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. QC Construction Products.
 - d. Scofield, L. M. Company.
 2. Color: As selected by Architect from manufacturer's full range.

- H. Water: Potable, complying with ASTM C 94/C 94M, except free of wash water from mixer washout operations.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anti-Hydro International, Inc.
 - b. BASF Corporation; Admixture Systems.
 - c. Euclid Chemical Company (The); an RPM company.
 - d. L&M Construction Chemicals, Inc.
 - e. W. R. Meadows, Inc.
 2. For integrally colored concrete, curing compound shall be pigmented type approved by color pigment manufacturer.
 3. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.6 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881/C 881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. BASF Corporation; Construction Systems.
 2. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

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

- B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
- C. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements. Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
- F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- G. Concrete Mixtures:
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Maximum W/C Ratio: 0.46.
 - 3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
 - 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.

2.8 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.
- B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.

- C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3 mm).
- D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ASI 117M).
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
 - 1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
 - 2. Do not use rust-stained steel form-facing material.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exterior corners and edges of cast-in-place architectural concrete.
- H. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- M. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
- N. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form-liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.2 REINFORCEMENT AND INSERT INSTALLATION

- A. General: Comply with Section 03 30 00 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
1. Schedule form removal to maintain surface appearance that matches approved field sample panels.
 2. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

- A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete. Align construction joint within rustications attached to form-facing material.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use bonding agent or epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

3.6 FINISHES, GENERAL

- A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
 - 1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.7 AS-CAST FORMED FINISHES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.

- C. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

3.8 EXPOSED-AGGREGATE FINISHES

- A. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample or mockup.
- B. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa). Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
1. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample or mockup.
- C. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
1. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.

2. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.
 3. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample or mockup, as follows:
 - a. Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
 - b. Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).
 - c. Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch (6 mm).
 - d. Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch (6 to 13 mm).
- D. Bushhammer Finish: Allow concrete to cure at least 14 days before starting bushhammer surface finish operations.
1. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.
 2. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
 3. Remove impressions of formwork and form facings with exception of tie holes.

3.9 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 (ACI 301M) for hot-weather protection during curing.
- B. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

- A. General: Comply with field quality-control requirements in Section 03 30 00 "Cast-in-Place Concrete."

3.11 REPAIR, PROTECTION, AND CLEANING

- A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
 1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.
- B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
- C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
- D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
 1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 03 33 00

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SECTION 04 20 00 - UNIT MASONRY**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Decorative burnished concrete masonry veneer units for Sport Complex Locker Room.
3. Clay brick-~~(Later)~~.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry-joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.
3. Cavity wall insulation.

C. Related Requirements:

1. Sheet S201, "General Notes and Schedules" for additional masonry construction and inspection requirements.
2. Section 05 12 00 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
- ~~3. Section 07 19 00 "Water Repellents" for water repellents applied to unit masonry assemblies.~~
- ~~4.3. Section 07 21 00 "Thermal Insulation" for cavity wall insulation.~~
- ~~5. Section 07 62 00 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.~~

1.3 DEFINITIONS

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

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 - 1. Decorative CMUs, in the form of small-scale units.
 - 2. Colored mortar.
 - 3. Weep holes/cavity vents.
- D. Samples for Verification: For each type and color of the following:
 - 1. Decorative CMUs, in the form of small-scale units.
 - 2. Clay face brick, in the form of straps of five or more bricks.**
 - ~~2.3.~~ Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 - ~~3.4.~~ Accessories embedded in masonry.

1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 - 1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

- c. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.**
- d. For exposed brick, include test report for efflorescence according to ASTM C 67.**

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

- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for each type of exposed unit masonry construction and typical exterior and interior walls in sizes approximately 72 inches (1800 mm) long by 96 inches (2400 mm) long by high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in each mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of

mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).

- d. Include water-resistive barrier, sheathing joint-and-penetration treatment, air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
 - e. **Include clay face brick on one face of interior unit masonry wall mockup.**
2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 4. Protect accepted mockups from the elements with weather-resistant membrane.
 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide bullnose units for outside corners unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
 - 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) BASF Corporation; Construction Systems.
 - 2) Euclid Chemical Company (The); an RPM company.
 - 3) GCP Applied Technologies Inc. (formerly Grace Construction Products).

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of indicated on the Drawings.
2. Density Classification: Lightweight units having an average density less than 105 lb/cu ft (1.680 kg/cu m).
3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

D. Decorative CMUs: ASTM C 90.

1. Products Subject to compliance with requirements, provide products by one of the following:
 - a. Echelon Masonry - Trenwyth, "Trendstone Plus Filled and Polished Masonry Units," with manufacturer's standard factory-applied water repellent, and extra water repellent for field finish final coat.
 - b. Anchor Block Company, "Anchor Burnished Masonry Units" with manufacturer's standard factory-applied water repellent, and extra water repellent for field finish final coat.
2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
3. Density Classification: Medium-weight.
4. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
5. Pattern and Texture:
 - a. Standard pattern, ground-face finish
 - a. Colors: As selected by Architect from manufacturer's full range.

2.5 MASONRY LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.
- C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:**
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C 216.**
1. **Basis of Design Products: Subject to compliance with requirements, provide the following or comparable products by a supplier acceptable to the Architect and the Owner:**
 - a. Face Brick Type 1: Kansas Brick and Tile.
 - b. Face Brick Type 2: Acme Brick.
 2. **Grade: SW.**
 3. **Type: FBX.**
 4. **Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.**
 5. **Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."**
 6. **Type 1 Brick Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 3-5/8 inches (92 mm) high by 11-5/8 inches (295 mm) long.**
 7. **Type 2 Brick Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.**
 8. **Application: Use where brick is exposed unless otherwise indicated.**
 9. **Colors and Textures:**
 - a. Face Brick Type 1: Kansas Brick & Tile, 500 C Brown; velour texture.
 - b. Face Brick Type 2: Acme Brick, Dove Gray; velour texture.

2.7 STONE TRIM UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide U.S. Stone Industries, Kansas Limestone Cottonwood "Bottom Ledge," honed finish with glass seam veins.**
- B. General: Provide limestone trim units for parapet caps, corner blocks, and window sills complying with ASTM C 568/C 568M and as indicated on the Drawings.**

- 1. Classification: II Medium Density, except as follows: absorption, 5 percent by weight maximum; density, 146 lb/cu. ft. (2336 kg/cu. m) minimum; compressive strength, 6832 psi (47 MPa) minimum; and modulus of rupture 947 psi (6.5 MPa) minimum.**
- C. Match Architect's samples for color, finish, veining, and other stone characteristics relating to aesthetic effects.**
- D. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.**
 - 1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."**

2.62.8 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Davis Colors.
 - b. Euclid Chemical Company (The); an RPM company.
- E. Aggregate for Mortar: ASTM C 144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.

- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. GCP Applied Technologies Inc. (formerly Grace Construction Products).
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. GCP Applied Technologies Inc. (formerly Grace Construction Products).
- I. Water: Potable.

2.72.9 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dur-O-Wal; a Hohmann & Barnard company.
 - b. Heckmann Building Products, Inc.
 - c. Hohmann & Barnard, Inc.
 - d. Wire-Bond.
- C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
1. Interior Walls: Hot-dip galvanized carbon steel.
 2. Exterior Walls: Hot-dip galvanized carbon steel.
 3. Wire Size for Side Rods: 0.187-inch (4.76-mm) diameter.
 4. Wire Size for Cross Rods: 0.187-inch (4.76-mm) diameter.
 5. Wire Size for Veneer Ties: 0.187-inch (4.76-mm) diameter.
 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.

7. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.
- E. Masonry-Joint Reinforcement for Multiwythe Masonry: Brick on both sides of concrete masonry units as indicated on the Drawings.
1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches (100 mm) wide, plus one side rod at each wythe of masonry 4 inches (100 mm) wide or less.

2.82.10 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
 2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
 3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units.
 2. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
 3. Wire: Fabricate from 3/16-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire.
- D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel.
- E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch- (1.52-mm-) thick steel sheet, galvanized after fabrication.
 - a. 0.108-inch- (2.74-mm-) thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire.
- F. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.
- H. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
 2. **Fabricate sheet metal anchor sections and other sheet metal parts from 0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication.**
 - ~~2.3.~~ Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
 - ~~3.4.~~ Screw-Attached, Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having holes for inserting vertical legs of wire tie formed to fit anchor section.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Heckmann Building Products, Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Wire-Bond.
 - 4.5. Stainless-Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless-steel shank.

2.92.11 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.016 inch (0.40 mm) thick.
 2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
 3. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
 4. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
 5. Solder metal items at corners.
- B. Flexible Flashing: Use the following unless otherwise indicated:
1. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637/D 4637M, 0.040 inch (1.02 mm) thick.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Carlisle Coatings & Waterproofing Inc.
 - 2) Heckmann Building Products, Inc.
 - 3) Hohmann & Barnard, Inc.
 - 4) Wire-Bond.
- C. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing or flexible flashing with a metal drip edge.
 4. Where flashing is fully concealed, use flexible flashing.
- D. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B 32, Grade Sn96, with acid flux of type recommended by stainless-steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

- F. Termination Bars for Flexible Flashing: Stainless steel bars 1/8 inch by 1 inch (3 mm by 25 mm).

2.102.12 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).
- D. Weep/Cavity Vent Products: Use one of the following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advanced Building Products Inc.
 - 2) Heckmann Building Products, Inc.
 - 3) Hohmann & Barnard, Inc.
 - 4) Wire-Bond.
 2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advanced Building Products Inc.
 - 2) CavClear/Archovations, Inc.
 - 3) Keene Building Products.
 - 4) Mortar Net Solutions.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advanced Building Products Inc.
 - b. CavClear/Archovations, Inc.

- c. Heckmann Building Products, Inc.
 - d. Hohmann & Barnard, Inc.
 - e. Mortar Net Solutions.
 - f. Wire-Bond.
2. Configuration: Provide one of the following:
- a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.

2.112.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - b. PROSOCO, Inc.

2.122.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
 2. Use portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For mortar parge coats, use Type N.
- C. Pigmented Mortar: Use colored cement product.
1. Pigments shall not exceed 10 percent of portland cement by weight.
 2. Mix to match Architect's sample.
 3. Application: Use pigmented mortar for exposed mortar joints with the following units:

- a. Decorative CMUs.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
- 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than strength indicated on the Drawings.
 - 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.**

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
- 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
- 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
- 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

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

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
 1. **Brick Type 1: Lay exposed brick in one-third running bond.**
 2. **Brick Type 2: Lay exposed brick in soldier coursing.**
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, **and wet brick if required before laying fresh masonry.**
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.

3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units and hollow brick with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

- 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.**
- 2. Allow cleaned surfaces to dry before setting.**
- 3. Wet joint surfaces thoroughly before applying mortar.**
- 4. Rake out mortar joints for pointing with sealant.**

~~B.D.~~ Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

- ~~1. For glazed masonry units, use a nonmetallic jointer 3/4 inch (19 mm) or more in width.~~

~~C.E.~~ Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

~~D.F.~~ Cut joints flush where indicated to receive cavity wall insulation and air barriers unless otherwise indicated.

3.6 COMPOSITE MASONRY

A. Bond wythes of composite masonry together as follows:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches

(610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (914 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.

- a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
- B. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
 1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
 1. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.

3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together as follows:
 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches (610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
 - a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.
 2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.

- b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.**
3. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- D. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
- 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
- 1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Embed connector sections in masonry joints.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and horizontally. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 24 inches (610 mm), around perimeter.
- B. Provide not less than 2 inches (50 mm) of airspace between back of masonry veneer and face of insulation.
- 1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.9 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.11 CONTROL AND EXPANSION JOINTS

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

4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. **Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.**
2. **Build flanges of factory-fabricated, expansion-joint units into masonry.**
3. **Build in compressible joint fillers where indicated.**
4. **Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10 mm) for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."**

- C.D.** Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07 92 00 "Joint Sealants," but not less than 3/8 inch (10 mm).

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.13 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches (200 mm), to the termination bar.
 3. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of inner wythe at least 8 inches (200 mm); with upper edge tucked under

- water-resistive barrier, lapping at least 4 inches (100 mm). Fasten upper edge of flexible flashing to inner wythe through termination bar.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
 5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07 92 00 "Joint Sealants" for application indicated.
 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick **and stone** sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes formed from wicking material 16 inches (400 mm) o.c.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- F. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.14 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage special inspectors to perform tests and inspections and prepare reports as indicated on Sheet S201 of the Project Structural Drawings. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Testing Prior to Construction: One set of tests.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- D. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.16 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

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- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 5. **Clean face brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.**
 - ~~5-6.~~ Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - ~~6-7.~~ Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.17 DECORATIVE CONCRETE MASONRY WATER REPELLENT APPLICATION

- A. Apply a final coat of manufacturer's recommended acrylic water repellent to decorative concrete masonry unit walls that are completed, cleaned, and fully cured and dry. Apply evenly to cover the entire surface without forming drips or runs and in accordance with the manufacturer's instructions.

3.18 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 20 00 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 20 00

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Structural steel.
 - 2. Field-installed shear connectors.
 - 3. Grout.
- B. Related Requirements:
 - 1. Section 05 31 00 "Steel Decking" for field installation of shear connectors through deck.
 - 2. Section 05 50 00 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
 - 3. Section 09 91 00 "Painting" for surface-preparation and priming requirements.

1.3 DEFINITIONS

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

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

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

1.6 ACTION SUBMITTALS

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

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, shop-painting applicators, professional engineer, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Shear stud connectors.
 - 4. Shop primers.
 - 5. Nonshrink grout.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or Endorsement P2 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- E. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using schematic details indicated.
 - 2. Use Allowable Stress Design; data are given at service-load level.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.

- B. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B or Grade C, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
 - 1. Weight Class: Standard.
 - 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 5. Finish: Plain.

2.4 PRIMER

- A. Primer: Comply with Section 09 91 00 "Painting."

2.5 GROUT

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

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 11, "Power Tool Cleaning to Bare Metal" or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.9 GALVANIZING

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

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
- D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

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

3.4 FIELD CONNECTIONS

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

3.5 FIELD QUALITY CONTROL

- A. Contractor shall engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports as indicated on Sheet S201 of the Structural Drawings.

3.6 REPAIRS AND PROTECTION

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

END OF SECTION 05 12 00

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SECTION 05 21 00 - STEEL JOIST FRAMING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
1. K-series steel joists.
 2. KCS-type K-series steel joists.
 3. LH- and DLH-series long-span steel joists.
 4. Joist accessories.
- B. Related Requirements:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing bearing plates in concrete.
 2. Section 04 20 00 "Unit Masonry" for installing bearing plates in unit masonry.
 3. Section 05 12 00 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.
- B. Shop Drawings:
1. Include layout, designation, number, type, location, and spacing of joists.
 2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
 3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 SEQUENCING

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

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. CMC Joist & Deck.
 - 3. New Millennium Building Systems, LLC.
 - 4. Structures of U.S.A., Inc.
 - 5. Valley Joist.
 - 6. Vulcraft; Nucor Vulcraft Group.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
 - 1. Use ASD; data are given at service-load level.
 - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: Vertical deflection of $1/360$ of the span.

2.3 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 - 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
- B. Provide holes in chord members for connecting and securing other construction to joists.
- C. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
- D. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
- E. Camber joists according to SJI's "Specifications."
- F. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds $1/4$ inch per 12 inches (1:48).

2.4 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:
 - 1. Joist Type: LH-series steel joists and DLH-series steel joists.
 - 2. End Arrangement: Underslung.
 - 3. Top-Chord Arrangement: Parallel.
- B. Provide holes in chord members for connecting and securing other construction to joists.
- C. Camber long-span steel joists according to SJI's "Specifications."
- D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds $1/4$ inch per 12 inches (1:48).

2.5 PRIMERS

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

2.6 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
- C. Steel bearing plates with integral anchorages are specified in Section 05 50 00 "Metal Fabrications."
- D. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Welding Electrodes: Comply with AWS standards.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.7 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

PART 3 - EXECUTION**3.1 EXAMINATION**

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

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165/E 165M.
 - b. Magnetic Particle Inspection: ASTM E 709.
 - c. Ultrasonic Testing: ASTM E 164.
 - d. Radiographic Testing: ASTM E 94.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

3.4 PROTECTION

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2 or power-tool cleaning according to SSPC-SP 3.
 2. Apply a compatible primer of same type as primer used on adjacent surfaces.

END OF SECTION 05 21 00

SECTION 05 31 00 - STEEL DECKING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof deck.
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
 - 2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.
 - 3. Section 05 50 00 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. Epic Metals Corporation.
 - 3. Nucor Corp.
 - 4. Verco Decking, Inc., a Nucor company.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
 - 2. Deck Profile: Type WR, wide rib.
 - 3. Profile Depth: 1-1/2 inches (38 mm).
 - 4. Design Uncoated-Steel Thickness: 0.0358 inch (0.91 mm).
 - 5. Span Condition: Triple span or more.
 - 6. Side Laps: Overlapped.

2.3 ACCESSORIES

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

- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Galvanizing Repair Paint: ASTM A 780/A 780M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

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

3.3 ROOF-DECK INSTALLATION

- A. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals as indicated on the Structural Drawings and as follows:
 - 1. Mechanically fasten with self-drilling, No. 12 (5.8-mm-) diameter or larger, carbon-steel screws.
- B. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped 2 inches (51 mm) minimum.
- C. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. mechanically fasten to substrate to provide a complete deck installation.
 - 1. Mechanically fasten cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- D. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Mechanical fasteners will be subject to inspection.
- C. Prepare test and inspection reports.

3.5 PROTECTION

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

END OF SECTION 05 31 00

SECTION 05 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Load-bearing wall framing.
 - 2. Non-load-bearing wall framing.
- B. Related Requirements:
 - 1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
 - 2. Section 09 21 16 "Gypsumboard Assemblies" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Power-actuated anchors.
 - 3. Mechanical fasteners.
 - 4. Vertical deflection clips.
 - 5. Miscellaneous structural clips and accessories.
- E. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. CEMCO; California Expanded Metal Products Co.
 - 3. ClarkDietrich Building Systems.
 - 4. MarinoWARE.
 - 5. SCAFCO Steel Stud Company.
 - 6. Steeler, Inc.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: ST33H (ST230H) for 43 mils and lighter units; ST50H (ST340H) for 54 mil and heavier units.
 - 2. Coating: G60 (Z180).
- B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: 50 (340), Class 1.
 - 2. Coating: G60 (Z180).

2.3 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As indicated on the Structural Drawings.
 2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
1. Minimum Base-Metal Thickness: Matching steel studs, unless noted otherwise on Structural Drawings.
 2. Flange Width: 1-1/4 inches (32 mm).
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As indicated on the Structural Drawings.
 2. Flange Width: 1-5/8 inches (41 mm).

2.4 NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As indicated on the Structural Drawings.
 2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: Matching steel studs.
 2. Flange Width: 1-1/4 inches (32 mm).
- C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AllSteel & Gypsum Products, Inc.
 - b. ClarkDietrich Building Systems.
 - c. MarinoWARE.
 - d. SCAFCO Steel Stud Company.
 - e. Steeler, Inc.

2.5 SOFFIT AND CEILING JOIST FRAMING

- A. Exterior Soffit and Ceiling Joists Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched with stiffened flanges, complying with ASTM C955 and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
 2. Flange Width: 1-5/8 inches (41 mm), minimum.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation 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. End clips.
 5. Foundation clips.
 6. Stud kickers and knee braces.
 7. Hole-reinforcing plates.
 8. Backer plates.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780/A 780M.
- B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.8 FABRICATION

- A. Fabricate cold-formed steel 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 or shearing; do not torch cut.
 3. Fasten cold-formed steel framing members by welding, screw fastening as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 4. Fasten other materials to cold-formed steel framing by welding or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.
- B. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal 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.
- G. Install insulation, specified in Section 07 21 00 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

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, and at spacings as follows:
 - 1. Anchor Spacing: As indicated on Structural Drawings.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch (3 mm) 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 follows:
 - 1. Stud Spacing: 16 inches (406 mm).

- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- E. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- F. Install headers over wall openings wider than stud spacing. Locate headers above openings. 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.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- G. 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.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- H. Install horizontal bridging in stud system, spaced vertically 48 inches (1220 mm). Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- I. Install steel sheet 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.
- J. 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 NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches (406 mm).
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Connect vertical deflection clips to bypassing studs and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.7 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- 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. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M 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 steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

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SECTION 05 50 00 - METAL FABRICATIONS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
1. Steel framing and supports for countertops.
 2. Steel tube reinforcement for low partitions.
 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 4. Shelf angles.
 5. Metal ladders.
 6. Metal bollards.
 7. Loose bearing and leveling plates for applications where they are not specified in other Sections.
- B. Products furnished, but not installed, under this Section include the following:
1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Requirements:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
 2. Section 04 20 00 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
 3. Section 05 12 00 "Structural Steel Framing."

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Nonslip aggregates and nonslip-aggregate surface finishes.
 2. Prefabricated building columns.
 3. Metal nosings and treads.
 4. Paint products.
 5. Grout.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
1. Steel framing and supports for overhead doors.
 2. Steel framing and supports for countertops.
 3. Steel tube reinforcement for low partitions.
 4. Steel framing and supports for mechanical and electrical equipment.
 5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 6. Shelf angles.
 7. Metal ladders.
 8. Metal bollards.
 9. Loose steel lintels.
- C. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design ladders.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated.
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 (Z275) coating; minimum 0.079-inch (2-mm) nominal thickness.
- F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- E. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 09 91 00 "Painting."
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports unless otherwise indicated.

2.7 SHELF ANGLES

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

2.8 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3.
 - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
 - 1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
 - 2. Siderails: Continuous, 1/2-by-2-1/2-inch (12.7-by-64-mm) steel flat bars, with eased edges.
 - 3. Rungs: 1-inch- (25-mm-) diameter steel bars.
 - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 - 6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Harsco Industrial IKG, a division of Harsco Corporation.
 - 2) SlipNOT Metal Safety Flooring; W.S. Molnar Company.
 - 7. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
 - 8. Galvanize and prime ladders, including brackets.
 - 9. Prime ladders with primer specified in Section 09 91 00 "Painting."

2.9 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime miscellaneous steel trim.
- D. Prime miscellaneous steel trim with primer specified in Section 09 91 00 "Painting."

2.10 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 - 1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 - 2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Prime bollards with primer specified in Section 09 91 00 "Painting."

2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.

2.12 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.13 STEEL WELD PLATES AND ANGLES

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

2.14 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean iron and steel items of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 09 91 00 "Painting" unless indicated.
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION**3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

- C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
1. Cast Aluminum: Heavy coat of bituminous paint.
 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

- A. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
1. Embed anchor bolts at least 4 inches (100 mm) in concrete.

- B. Anchor bollards in concrete in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.
- C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- D. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.4 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 00 "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

SECTION 06 10 00 - ROUGH CARPENTRY**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. Rooftop equipment bases and support curbs.
2. Wood blocking, cants, and nailers.
3. Wood furring and grounds.
4. Wood sleepers.
5. Plywood backing panels.

B. Related Requirements:

1. Section 06 17 53 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.
2. Section 31 31 16 "Termite Control" for site application of borate treatment to wood framing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. 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 based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS**2.1 WOOD PRODUCTS, GENERAL**

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
- B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

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

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
 - 7. Utility shelving.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:
 - 1. Mixed southern pine or southern pine; No. 3 grade; SPIB.
 - 2. Hem-fir or hem-fir (north); Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.
 - 3. Spruce-pine-fir (south) or spruce-pine-fir; Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 - 4. Eastern softwoods; No. 3 Common grade; NeLMA.
 - 5. Northern species; No. 3 Common grade; NLGA.
 - 6. Western woods; Standard or No. 3 Common grade; WCLIB or WWPA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

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

2.6 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.
1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.7 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).
- B. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
- C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION**3.1 INSTALLATION, GENERAL**

- A. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install shear wall panels to comply with manufacturer's written instructions.
- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
- F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. ICC-ES evaluation report for fastener.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally at 24 inches (610 mm) o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) o.c.

3.4 PROTECTION

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

END OF SECTION 06 10 00

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SECTION 07 21 00 - THERMAL 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. Extruded polystyrene foam-plastic board.
 - 2. Glass-fiber blanket.
 - 3. Glass-fiber board.
 - 4. Loose-fill insulation.
- B. Related Requirements:
 - 1. Section 04 20 00 "Unit Masonry" for insulation installed in masonry cells.
 - 2. Section 07 24 19 "Water-Drainage Exterior Insulation and Finish System (EIFS)" for rigid insulation board installed with exterior finish system.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

- A. Extruded Polystyrene Board, Type VII: ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.

2.2 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Owens Corning.

2.3 GLASS-FIBER BOARD

- A. Glass-Fiber Board, Unfaced: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84, passing ASTM E 136 for combustion characteristics. Nominal density of 2.25 lb/cu. ft (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.

2.4 LOOSE-FILL INSULATION

- A. Cellulosic-Fiber Loose-Fill Insulation: ASTM C 739, chemically treated for flame-resistance, processing, and handling characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Central Fiber LLC.
 - b. Hamilton Manufacturing Inc.
- B. Glass-Fiber Loose-Fill Insulation: ASTM C 764, Type II for poured application; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

2.5 SPRAY-APPLIED CELLULOSIC INSULATION

- A. Self-Supported, Spray-Applied Cellulosic Insulation: ASTM C 1149, Type III (materials containing an adhesive mixed with water during application; intended for application on attic floors), chemically treated for flame-resistance, processing, and handling characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Central Fiber LLC.
 - b. Hamilton Manufacturing Inc.
 - c. International Cellulose Corp.

2.6 ACCESSORIES

- A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- B. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) in from exterior walls.

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 - 5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
- C. Loose-Fill Insulation: Apply according to ASTM C 1015 and manufacturer's written instructions. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
- D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.5 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

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SECTION 07 41 16 - STANDING-SEAM METAL ROOF PANELS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes standing-seam metal roof, **expansion joints**, fascia panels, underlayment, and rigid composite insulation.
- B. Related Sections:
1. Section 07 01 50 "Preparation for Reroofing" for removal of existing standing seam metal roofing system and protection of exposed surfaces.
 2. Section 07 72 53 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof and fascia accessories and roof-mounted equipment.
 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 5. Review structural loading limitations of deck during and after roofing.
 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 8. Review temporary protection requirements for metal panel systems during and after installation.
 9. Review procedures for repair of metal panels damaged after installation.
 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; insulation, details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, fasciae, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Calculations: Include calculations with registered engineer seal, verifying roof panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

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

- C. Benchmark Samples (Mockups): Provide a complete benchmark sample of a complete section of roof system.
 - 1. Once sequence of removal of existing roofing and installation of new materials is established, the Architect will designate a specific roof area for constructing the benchmark sample to demonstrate the complete system.
 - a. Roof Surfaces: Construct at least 400 square feet (36 sq. m).
 - 2. Approval of benchmark does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved benchmark shall remain undisturbed throughout the construction period.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.9 FIELD CONDITIONS

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

1.10 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
1. Roof Live Load: 20 psf
 2. Flat-Roof Snow Load: 22 psf
 3. Snow Exposure Factor: $C_e=1.0$
 4. Basic wind speed (3-second gust):
 - a. $V_{ult} = 120$ mph Ultimate
 - b. $V_{asd} = 93$ mph Nominal
 5. Wind exposure category: C
 6. Deflection Limits: For wind loads, no greater than 1/240 of the span.

- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 at the following test-pressure difference:
1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).
- D. Wind-Uplift Resistance: Provide metal roof and fascia panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 90.
- E. FM Global Listing: Provide metal roof and fascia panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
1. Fire/Windstorm Classification: Class 1A- 90.
 2. Hail Resistance: SH.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF AND FASCIA PANELS

- A. General: Provide factory-formed metal roof and fascia panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof and Fascia Panels: Formed with vertical ribs at panel edges and smooth striated pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; Berridge Cee-Lock or comparable product by one of the following:

- a. CENTRIA Architectural Systems.
 - b. Fabral.
 - c. MBCI; a division of NCI Group, Inc.
 - d. Petersen Aluminum Corporation.
2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.029 inch (0.74 mm) minimum.
 - b. Exterior Finish: Three-coat fluoropolymer.
 - c. Color: Berridge, Colonial Red.
 3. Clips: Continuous clips with vinyl weatherseal insert to accommodate thermal movement and clip bearing plates for rigid insulation.
 - a. Material: 0.029 inch (0.74 mm) nominal thickness, G90 (Z180) hot-dip zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 4. Joint Type: Single folded.
 5. Panel Coverage: 16.5 inches (419 mm).
 6. Panel Height: 1.5 inches (38 mm).

2.3 ROOF TO WALL EXPANSION JOINTS

- A. **Roof Expansion Joint: Factory-fabricated, continuous, waterproof, joint cover as indicated on the Drawings; consisting of a formed metal cover secured to galvanized steel frames, with water-resistant membrane between cover and frames, and with provision for securing assembly to vertical substrate and sealing assembly to roofing membrane or flashing.**
 1. **Joint Movement Capability: Plus and minus 25 percent of joint size.**
 2. **Frame Members: Minimum 0.029 inch (0.74 mm) nominal thickness, G90 (Z180) hot-dip zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.**
 3. **Cover: Metallic coated sheet steel to match metal roof panel.**
 4. **Corner, Intersection, and Transition Units: Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints.**
 5. **Accessories: Provide splicing units, adhesives, and other components as recommended by roof-expansion-joint manufacturer for complete installation.**
 6. **Secondary Seal: Continuous, waterproof membrane within joint and attached to substrate on sides of joint below the cover.**
- B. **Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:**
 1. **Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.**

2. **Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.**
- C. **Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:**
 1. **Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.**
- D. **Finishes: Match metal roof panels.**

2.32.4 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
 3. Basis-of-Design Product: Subject to compliance with requirements, provide "Grace Ice & Water Shield® HT", GCP Applied Technologies Inc. (formerly Grace Construction Products) or comparable product by one of the following:
 - a. Carlisle Residential; a division of Carlisle Construction Materials.
 - b. Drexel Metals.
 - c. GCP Applied Technologies Inc. (formerly Grace Construction Products).
 - d. Henry Company.
 - e. Owens Corning.

2.42.5 COMPOSITE INSULATED ROOF SHEATHING

- A. Plywood-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C 1289, Type V with DOC PS 2, Exposure 1, plywood on one face and felt or glass-fiber mat facer on the other surface.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Roofing Corporation.
 - b. Cornell Corporation.
 - c. Dow Chemical Company (The).
 - d. Johns Manville; a Berkshire Hathaway company.
 - e. Rmax, Inc.
 2. Polyisocyanurate-Foam Thickness: 2-3/8 inches (60 mm).

3. CDX Plywood: 5/8 inch (15.9 mm).
4. Compressive Strength: 25 psi (172 kPa).
5. Size: 48 by 96 inches (1219 by 2438 mm).
6. Thickness: .30 inches (76 mm)

2.52.6 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof and fascia panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof and fascia panels.
- E. Downspouts: Formed from same material as roof and fascia panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.
4. Vinyl Weatherseal: Manufacturer's standard seal for watertight installations.

2.62.7 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.72.8 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine primary and secondary roof and fascia framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof and fascia panel manufacturer.
 - 2. Examine solid roof and fascia sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof and fascia panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over composite insulation substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire roof and fascia surface.

3.4 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with end joints staggered not less than 12 inches (305 mm) in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
 - d. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - e. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
 - 1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - f. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
 - g. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - h. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
 - i. Trim insulation so that water flow is unrestricted.

- j. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
- k. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

3.5 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels to be level to 1/4 inch in 20 ft. (6 mm in 6.1 m).
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 4. Install flashing and trim as metal panel work proceeds.
 - 5. Panels should be continuous without end laps.
 - 6. Align bottoms of metal panels and fasten.
 - 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof and fascia panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof and Fascia Panel Installation: Fasten metal roof and fascia panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to substrate with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied vinyl weatherseal.
 - 4. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or vinyl tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or vinyl tape between panels and protruding equipment, vents, and accessories.

- c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
5. Panel Alignment: Align vertical ribs of roof and fascia panels.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof and fascia panel manufacturers; or, if not indicated, types recommended by metal roof and fascia panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
- J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.6 EXPANSION JOINT, REGLET, COUNTERFLASHING INSTALLATION

- A. General: Coordinate installation of expansion joints, reglets, and counterflashings with installation of metal roof panels.**

1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
 2. Install roof expansion joints true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 3. Provide for linear thermal expansion of roof expansion joint materials.
 4. Provide uniform, neat seams.
 5. Install roof expansion joints to fit substrates and to result in watertight performance.
 6. Torch cutting of roof expansion joints is not permitted.
- B. Directional Changes and Other Expansion-Control Joint Systems:** Coordinate installation of roof expansion joints with other expansion-control joint systems to result in watertight performance. Install units at directional changes and at transitions between roof expansion joints and exterior expansion-control joint systems specified in Section 07 95 13 "Expansion Joint Cover Assemblies" to provide continuous, uninterrupted, and watertight joints.
- C. Surface-Mounted Reglets:** Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
- D. Counterflashings:** Insert counterflashings into reglets; ensure that counterflashings overlap 4 inches (100 mm) over top edge of flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.63.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.73.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof and fascia panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof and fascia panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.83.9 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 16

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SECTION 07 42 93 - SOFFIT PANELS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes metal soffit panels.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

1.10 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.

- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
1. Wind Loads: As indicated on Drawings.
 2. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METAL SOFFIT PANELS

- A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.
- B. V-Groove-Profile Metal Soffit Panels: Perforated panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with a V-groove joint between panels.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company Vented Vee-Panel or comparable product by one of the following:
 - a. ATAS International, Inc.
 - b. Fabral.
 - c. McElroy Metal, Inc.
 - d. Petersen Aluminum Corporation.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.024 inch (0.61 mm).
 - b. Exterior Finish: Two-coat fluoropolymer.
 - c. Color: Manufacturer's standard White.
3. Panel Coverage: 12-3/4 inches (324 mm).
4. Panel Height: 0.375 inch (10 mm).

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are 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.
- C. Steel Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
 1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 1. Shim or otherwise plumb substrates receiving metal panels.
 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal panel work proceeds.
 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

- B. Fasteners: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Interlocking Soffit Panels: Fasten metal panels to supports with fasteners at joint at location and spacing recommended by manufacturer.
 - 1. Apply panels and associated items true to line for neat and weathertight enclosure.
 - 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 - 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 - 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 93

SECTION 07 71 00 - ROOF 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. Section Includes:
1. Roof-edge drainage systems.
- B. Related Requirements:
1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
 2. Section 07 13 13 "Asphalt Shingles" for roof-drip edge fascia.
 3. Section 07 72 53 "Snow Guards" for manufactured snow guard devices.
 4. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
- C. Preinstallation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
 2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 3. Review roof drainage and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof specialties.
1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
 2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.

4. Detail termination points and assemblies, including fixed points.
 5. Include details of special conditions.
- C. Samples: For each type of roof specialty and for each color and texture specified.
- D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
- E. Samples for Verification:
1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
 2. Include roof-edge drainage systems made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For roof-edge flashings, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class and SPRI ES-1 tested to specified design pressure.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 07 13 13 "Asphalt Shingles."
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ATAS International, Inc.
 2. CopperCraft by FABRAL.
 3. Hickman Company, W. P.
 4. Merchant & Evans Inc.
- B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
1. Zinc-Coated Steel: Nominal 0.034-inch (0.86-mm) thickness.
 2. Gutter Profile: Style A according to SMACNA's "Architectural Sheet Metal Manual."
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Gutter Supports: Gutter brackets with finish matching the gutters.
- C. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Zinc-Coated Steel: Nominal 0.034-inch (0.86-mm) thickness.
- D. Zinc-Coated Steel Finish: Two-coat fluoropolymer.
1. Color: As selected by Architect from manufacturer's full range.

2.3 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

2.4 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
- B. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Coil-Coated Galvanized-Steel Sheet Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A 755/A 755M and coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.

4. Torch cutting of roof specialties is not permitted.
 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

3.3 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 36 inches (910 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
1. Install gutter with expansion joints at locations not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
1. Connect downspouts to underground drainage system indicated.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 71 00

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SECTION 07 72 00 - ROOF 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. Roof hatches.
- B. Related Sections:
 - 1. Section 05 50 00 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
 - 2. Section 05 52 13 "Pipe and Tube Railings" for safety railing systems not attached to roof-hatch curbs.
 - 3. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
 - 4. Section 07 71 00 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.

1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco Company (The); Type E Roof Hatch or comparable product by one of the following:
 - a. Babcock-Davis.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Milcor; Commercial Products Group of Hart & Cooley, Inc.
 - d. Pate Company (The).
- B. Type and Size: Single-leaf lid, 36 by 36 inches (900 by 900 mm).
- C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.
- D. Hatch Material: Zinc-coated (galvanized) steel sheet.

1. Thickness: 0.079 inch (1.9 mm).
 2. Finish: Baked enamel or powder coat.
- E. Construction:
1. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 3. Insulation: Glass-fiber board; 1 inch (25 mm) thick.
 4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 6. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
 7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.
- F. Hardware: Spring operators, hold-open arm, galvanized-steel spring latch with turn handles, galvanized-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
- G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco Company (The); Type RL2-E or comparable product by one of the following:
 - a. Babcock-Davis.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Milcor; Commercial Products Group of Hart & Cooley, Inc.
 - d. Pate Company (The).
 2. Height: 42 inches (1060 mm) above finished roof deck.
 3. Posts and Rails: Aluminum pipe, 1-1/4 inches (31 mm) in diameter, schedule 40.
 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 8. Fabricate joints exposed to weather to be watertight.
 9. Fasteners: Manufacturer's standard, finished to match railing system.
 10. Finish: Manufacturer's standard.
 - a. Color: Yellow.

- H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco Company (The); Type UL-1 or comparable product by one of the following:
 - a. Babcock-Davis.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Milcor; Commercial Products Group of Hart & Cooley, Inc.
 - d. Pate Company (The).
 2. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
 3. Height: 42 inches (1060 mm) above finished roof deck.
 4. Post: High strength square tubing with a pull up loop installed at the upper end of the post.
 5. Material: Steel.
 6. Balancing spring: Stainless steel spring balancing mechanism for raising and lowering the safety post.
 7. Hardware: All mounting hardware shall be Type 316 stainless steel.
 8. Finish: Manufacturer's standard baked enamel or powder coat.
 - a. Color: Yellow.

2.3 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
1. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).
 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- B. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- C. Steel Tube: ASTM A 500/A 500M, round tube.
- D. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Galvanized-Steel Tube: ASTM A 500/A 500M, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- F. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C 726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- E. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.

2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
- C. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Attach ladder-assist post according to manufacturer's written instructions.
- D. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 00 "Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

SECTION 07 92 00 - JOINT SEALANTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Urethane joint sealants.
 - 4. Mildew-resistant joint sealants.
 - 5. Polysulfide joint sealants.
 - 6. Latex joint sealants.
 - 7. Acoustical joint Sealants

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.

- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - 1. Joint-sealant location and designation.
 - 2. Manufacturer and product name.
 - 3. Type of substrate material.
 - 4. Proposed test.
 - 5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion-Test Reports: For each sealant application tested.
- G. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide elastomeric joint sealants that are water, ozone, chemical, and UV resistant and will not detrimentally affect joint substrates.
- C. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

2.3 SILICONE JOINT SEALANTS

- A. Silicone, Nonstaining, S, NS, 50, NT (JS-S1): Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 756 SMS.
 - b. Momentive Performance - Silicones; SilPruf NB SCS9000.
 - c. Pecora Corporation; 898NST.
 - d. Tremco Incorporated; Spectrem 2.
- B. Silicone, S, NS, 50, NT (JS-S2): Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; Dow Corning® 791 Silicone Weatherproofing Sealant.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2000 SilPruf.
 - c. Pecora Corporation; PCS.
 - d. Tremco Incorporated; Spectrem 2.

2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT (JS-U1): Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal TX 1.
 - b. Pecora Corporation; Dynatrol I-XL.
 - c. Sika Corporation, Construction Products Division; Sikaflex - 1a.
 - d. Tremco Incorporated; Dymonic.
- B. Urethane, S, P, 25, T, NT (JS-U2): Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal SL 1.
 - b. Pecora Corporation; NR-201.
- C. Urethane, M, P, 25, T, NT (JS-U3): Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and NT.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal SL 2.
 - b. LymTal International Inc; Iso-Flex 880 GB.
 - c. Pecora Corporation; Dynatrol II SG.
 - d. Sika Corporation; Joint Sealants; Sikaflex 2c SL.
 - e. Tremco Incorporated; THC 900/901.

2.5 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT (JS-S3): Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; Dow Corning® 786 Silicone Sealant -.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
 - c. Tremco Incorporated; Tremsil 200.

2.6 LATEX JOINT SEALANTS

- A. Acrylic Latex (JS-L1): Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; Sonolac.
 - b. Pecora Corporation; AC-20.
 - c. Tremco Incorporated; Tremflex 834.

2.7 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant (JS-A1): Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Available Products: Subject to compliance with requirements, provide one of the following:
 - a. Momentive Performance Materials; RCS 20.
 - b. Pecora Corporation; AC-20 FTR.
 - c. Tremco Incorporated; Tremco Acoustical Sealant.
 - d. USG Corporation; SHEETROCK Brand Acoustical Sealant.

2.8 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation; Construction Systems; MasterSeal 920 & 921.
 - b. Construction Foam Products; a division of Nomaco, Inc.; SOF Rod or HBR.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to exterior concrete and masonry substrates.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 2000 feet (600 m) of joint length for each kind of sealant and joint substrate.
 - b. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other

requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-U1).
 - 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, NS, 25, NT.
- B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces (JS-U2).
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in ceramic tile flooring.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
- C. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces (JS-U3).
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, M, P, 25, T, NT.

- D. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces (JS-S1).
1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone veneer.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - f. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
- E. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces (JS-S2).
1. Joint Locations:
 - a. Joints between metal panels.
 - b. Perimeter joints between metal panels and frames of doors, windows, and louvers.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, S, NS, 50, NT.
- F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-S3).
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
- G. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement (JS-L1).
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.

END OF SECTION 07 92 00

SECTION 07 95 13 - EXPANSION JOINT COVER ASSEMBLIES**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 interior and exterior building expansion joint cover assemblies.
- B. Related Requirements:
 - 1. Section 07 41 16 "Standing Seam Metal Roof Panels" for roof expansion joint cover assemblies.
 - 2. Section 07 92 00 "Joint Sealants" for elastomeric sealants and preformed compressed-foam sealants without metal frames.
 - 3. Section 09 21 16 "Gypsum Board Assemblies" for coordination of installation of expansion joint covers in gypsumboard assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
- B. Shop Drawings: For each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by 6 inches (150 mm) long in size.
- D. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
 - 1. Manufacturer and model number for each expansion joint cover assembly.
 - 2. Expansion joint cover assembly location cross-referenced to Drawings.
 - 3. Nominal, minimum, and maximum joint width.
 - 4. Movement direction.
 - 5. Materials, colors, and finishes.
 - 6. Product options.

7. Fire-resistance ratings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Furnish units in longest practicable lengths to minimize field splicing.
- B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E 1966 by a qualified testing agency.
 1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.
- B. Expansion Joint Design Criteria:
 1. Type of Movement: Thermal.
 - a. Nominal Joint Width: As indicated on Drawings.
 - b. Minimum Joint Width: [As indicated on Drawings] <Insert width>.
 - c. Maximum Joint Width: [As indicated on Drawings] <Insert width>.

- C. Single-Source Responsibility: Obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.

2.3 EXTERIOR EXPANSION JOINT COVERS

- A. Exterior Elastomeric-Seal Joint Cover (Wall/Wall): Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.
1. Basis-of-Design Product: Subject to compliance with requirements, provide BASF Corp. - Watson Bowman Acme Corp. WSW-200 or comparable product by one of the following:
 - a. Construction Specialties, Inc.
 - b. InPro Corporation (IPC).
 - c. Nystrom, Inc.
 2. Application: Wall to wall.
 3. Installation: Recessed.
 4. Metal: Aluminum, mill finish.
 5. Seal: Preformed elastomeric membrane or extrusion.
 - a. Color: Gray.
- B. Exterior Elastomeric-Seal Joint Cover (Corner Wall/Wall): Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.
1. Basis-of-Design Product: Subject to compliance with requirements, provide BASF Corp. - Watson Bowman Acme Corp. WSC -200 or comparable product by one of the following:
 - a. Construction Specialties, Inc.
 - b. InPro Corporation (IPC).
 - c. Nystrom, Inc.
 2. Application: Wall to corner.
 3. Installation: Recessed.
 4. Metal: Aluminum, mill finish.
 5. Seal: Preformed elastomeric membrane or extrusion.
 - a. Color: Gray.

2.4 INTERIOR EXPANSION JOINT COVERS

- A. Interior Elastomeric-Seal Joint Cover (Wall/Wall): Assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.
1. Basis-of-Design Product: Subject to compliance with requirements, provide BASF Corp. - Watson Bowman Acme Corp. WSW-200 or comparable product by one of the following:

- a. Construction Specialties, Inc.
 - b. InPro Corporation (IPC).
 - c. Nystrom, Inc.
2. Application: Wall to wall.
 3. Installation: Recessed.
 4. Metal: Aluminum, mill finish.
 5. Seal: Preformed elastomeric membrane or extrusion.
 - a. Color: Gray.

2.5 CEILING EXPANSION JOINT COVERS

- A. Elastomeric-Seal Ceiling Joint Cover: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc. Model FWS-200 or comparable product by one of the following:
 - a. BASF Corp. - Watson Bowman Acme Corp
 - b. InPro Corporation (IPC).
 - c. Nystrom, Inc.
 2. Application: Ceiling to ceiling.
 3. Metal: Aluminum, mill finish.
 4. Seal: Preformed elastomeric membranes or extrusions.
 - a. Color: White.

2.6 MATERIALS

- A. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), Alloy 6061-T6 for sheet and plate.
 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.
- D. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 ALUMINUM FINISHES

- A. Mill finish.

2.8 ACCESSORIES

- A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.
 - 1. Provide where indicated on Drawings.
- B. Manufacturer's stainless-steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.
 - 1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

2. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 3. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
 4. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 5. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.
 7. Coordinate ceiling expansion joint covers with drywall finishing.
- C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
1. Provide in continuous lengths for straight sections.
 2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.
- F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.
1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
- G. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

- A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 07 41 16 "Standing Seam Metal Roof Panels." Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.

3.5 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

- B. Protect the installation from damage by work of other Sections.
- C. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13

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SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Interior standard **heavy duty and extra heavy-duty** steel doors and frames.
 - 2. Exterior standard **extra heavy-duty** steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

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

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

- B. Shop Drawings: Include the following:
1. Elevations of each door type.
 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 7. Details of anchorages, joints, field splices, and connections.
 8. Details of accessories.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

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

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following members of the Steel Door Institute (SDI):
1. Amweld International, LLC.
 2. Ceco Door; ASSA ABLOY.
 3. Mesker Door Inc.
 4. Pioneer Industries.

5. Republic Doors and Frames.
6. Steelcraft; an Allegion brand.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. (2.27 W/K x sq. m) when tested according to ASTM C 518.

2.3 INTERIOR STANDARD **HEAVY-DUTY** STEEL DOORS AND FRAMES

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

2.4 EXTERIOR **AND INTERIOR** STANDARD **EXTRA HEAVY-DUTY** STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

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

2.5 FRAME ANCHORS

- A. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.6 MATERIALS

- A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- B. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- C. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- D. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- E. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.7 FABRICATION

- A. Door 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 (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.8 STEEL FINISHES

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

- a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - c. Install door silencers in frames before filling with mortar, grout, or plaster.**
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.**
 - e. Check plumb, square, 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 will be filled with mortar, grout, or plaster.**
2. Fire-Rated Openings: Install frames according to NFPA 80.
 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - a. Fill voids of hollow metal frames at Doors E105, E107, E110, and E114.**
 6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 08 11 13

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SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Requirements:
 - 1. Section 08 80 00 "Glazing" for fire-protection rated glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
 - a. Provide Samples for each species of veneer and solid lumber required.
 - b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
3. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of door, from manufacturer.
- B. Sample Warranty: For special warranty.
- C. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during remainder of construction period.

1.8 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eggers Industries.
 2. Graham Wood Doors; ASSA ABLOY Group company.
 3. Marshfield DoorSystems, Inc.
 4. VT Industries Inc.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
 1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
 2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Temperature-Rise Limit: At exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 4. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
- D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

E. Structural-Composite-Lumber-Core Doors:

1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf (3100 N).
 - b. Screw Withdrawal, Edge: 400 lbf (1780 N).

F. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
 - a. 5-inch (125-mm) top-rail blocking.
 - b. 5-inch (125-mm) bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch (125-mm) midrail blocking, in doors indicated to have armor plates.
 - d. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 550 lbf (2440 N) per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade AA faces.
2. Species: Red oak.
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Exposed Vertical Edges: Same species as faces - edge Type A.
8. Core: Either glued wood stave or structural composite lumber.
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.

2.4 LIGHT FRAMES

- A. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 "Glazing."

2.6 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
 - 1. Grade: Premium.
 - 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 11, catalyzed polyurethane.
 - 3. Staining: None required.
 - 4. Sheen: Satin.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.

2. Reject doors with defects.

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

3.2 INSTALLATION

A. Hardware: For installation, see Section 08 71 30 "Door Hardware - Science Wing."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.

2. Install smoke- and draft-control doors according to NFPA 105.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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. Storefront framing.
 - 2. Manual-swing entrance doors.
 - 3. **Aluminum faced laminated infill panels for swing doors.**

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 4. Include point-to-point wiring diagrams showing the following:

- a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
- 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Preconstruction Laboratory Mockup Testing Submittals:
- 1. Testing Program: Developed specifically for Project.
 - 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
 - 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- B. Qualification Data: For Installer and field testing agency.
- C. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
- 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- D. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Source quality-control reports.

- F. Field quality-control reports.
- G. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Insulated Infill Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace insulated infill panels that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures including delamination.**
- b. Deterioration of metals and other materials beyond normal weathering.**

2. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:

- a. Thermal stresses transferring to building structure.
- b. Glass breakage.
- c. Noise or vibration created by wind and thermal and structural movements.
- d. Loosening or weakening of fasteners, attachments, and other components.
- e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).
 - a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
- E. Structural: Test according to ASTM E 330/E 330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
 2. Entrance Doors:
 - a. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. (2.54 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.38 Btu/sq. ft. x h x deg F (2.15 W/sq. m x K) as determined according to NFRC 100.
 2. Thermal Transmittance (U-factor): Operable units shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
 3. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas as a system shall have SHGC of no greater than 0.40 as determined according to NFRC 200.

4. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than 45 as determined according to NFRC 500.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. EFCO Corporation.
 2. Kawneer North America; an Alcoa company.
 3. Manko Window Systems, Inc.
 4. Oldcastle BuildingEnvelope™.
 5. YKK AP America Inc.
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.4 FRAMING COMPONENTS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Exterior Framing Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Frame Depth: Not less than 4-1/2 inches (114 mm).
 4. Face Width: Not less than 2 inches (51 mm).
 5. Glazing Plane: Center.
 6. Finish: Clear anodic finish.
 7. Fabrication Method: Field-fabricated stick system.
 8. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 9. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
1. Door Construction: 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width.
 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
- B. Insulated Infill Panels: Laminated, aluminum-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.**
1. **Basis-of-Design Product: Subject to compliance with requirements, provide Mapes Industries, Inc. Mapes-R panels or comparable product by manufacturer with a minimum of 25 years panel laminating experience and comparable published warranties.**
 2. **Overall Panel Thickness: 1 inch (25.4 mm).**
 3. **Exterior Skin: Aluminum.**
 - a. **Thickness: 0.036 inch (0.91 mm).**
 - b. **Finish: Match framing system.**
 - c. **Texture: Smooth.**
 - d. **Backing Sheet: 0.157-inch- (4-mm-) thick water and impact resistant cement board.**
 4. **Interior Skin: Aluminum.**
 - a. **Thickness: 0.036 inch (0.91 mm).**
 - b. **Finish: Matching storefront framing.**
 - c. **Texture: Smooth.**
 - d. **Backing Sheet: 0.157-inch- (4-mm-) thick water and impact resistant cement board.**
 5. **Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.**

2.6 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Sections 08 71 ~~xx 00~~ **for facility** "Door Hardware."

2.7 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.8 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 3. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 4. Structural Profiles: ASTM B 308/B 308M.
- B. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
 4. Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.9 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
 3. Use exposed fasteners with countersunk Phillips screw heads, fabricated from 300 series stainless steel.

- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
- E. Rigid PVC Filler.

2.10 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate components for assembly using screw-spline system.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At exterior doors, provide weather sweeps applied to door bottoms.

- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.11 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.12 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "Joint Sealants," to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 08 80 00 "Glazing."
- F. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Insulated Infill Panels:**
1. Erect panels plumb, level and true.
 2. Glaze panels securely and in accordance with approved shop drawings and manufacturer's instructions to allow for necessary thermal movement and structural support.
 3. Do not install panels that are observed to be defective including warped, bowed, dented, scratched and delaminating components.
 4. Seal joints as required using methods and materials as previously specified.
 5. Separate dissimilar metals using gasketed fasteners and blocking to eliminate the possibility of electrolytic reaction.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).

- b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of three tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Perform a minimum of three tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

- A. Entrance Door Hardware:
 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door

hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.7 ADJUSTING AND CLEANING

- A. Remove masking film as soon as possible after installation. Masking intentionally left in place after panel installation will be the responsibility of the contractor.**
- B. Weep holes and drainage channels must be unobstructed and free from dirt and sealant.**

END OF SECTION 08 41 13

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SECTION 08 51 13 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes projected-out, casement aluminum windows for exterior locations.
- B. Related Requirements:
 - 1. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
 - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
 - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
 - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.
 - 1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

- C. Samples: For each exposed product and for each color specified, 2 by 4 inches (50 by 100 mm) Insert dimensions in size.
- D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.

2. Warranty Period:
 - a. Window: 10 years from date of Substantial Completion.
 - b. Glazing Units: 10 years from date of Substantial Completion.
 - c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 1. Minimum Performance Class: AW.
 2. Minimum Performance Grade: 80.
- C. Air Test Performance Requirements
 1. Air infiltration maximum 0.1 cfm per square foot at 6.24 psf pressure differential when tested in accordance with ASTM E283.
- D. Water Test Performance Requirements
 1. No uncontrolled water leakage at 12.00 psf static pressure differential, with water application rate of 5 gallons/hr/sq ft when tested in accordance with ASTM E331.
- E. Condensation Resistance and Thermal Transmittance Performance Requirements
 1. Perform thermal tests in accordance with the configuration specified in AAMA 1503.1.
 - a. Thermal Transmittance ("U" Factor) shall not exceed 0.46 BTU/hr/sf/deg F at 15 mph exterior wind.
 - b. Condensation Resistance Factor (CRF) requirements: CRF minimum 57 (Frame) and CRF minimum 57 (specimen).
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C) ambient; 180 deg F (100 deg C) material surfaces.

2.3 ALUMINUM WINDOWS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Manko Window Systems, Inc. Casement Window System Series 3725i or comparable product by one of the following:
 1. EFCO Corporation.
 2. Kawneer North America, an Arconic company.
 3. YKK AP America Inc.
- B. Operating Types: Provide the following operating types in locations indicated on Drawings:
 1. Casement: Project out.
 2. Fixed.
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Glass: Clear annealed glass, ASTM C 1036, Type 1, Class 1, q3.
 1. Kind: Fully tempered where indicated on Drawings.
- E. Insulating-Glass Units: ASTM E 2190.
 1. Glass: ASTM C 1036, Type 1, Class 1, q3.
 - a. Tint: Clear.
 - b. Kind: Fully tempered.
 2. Lites: Two.
 3. Filling: Fill space between glass lites with air.
- F. Integral Louver Blinds: Glass manufacturer's standard, horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between the insulating unit and the take-out interior sash, and operated by hardware located on inside face of sash
 1. 5/8 inch wide aluminum slat blinds. Blind color shall be brushed aluminum.
 - a. Operation: Tilt, raising, and lowering.
 2. Tilt-control knob shall be located on the interior face of access panel at the bottom of the right jamb. Raise and lower pull cords shall be located between glass for access only when access panel is opened.

3. Tilt-control knob shall incorporate a “slip clutch” feature.
- G. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.
1. Dual Glazing System:
 - a. Interior Lite: Glass.
 - b. Exterior Lite: Insulating-glass unit.
- H. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.
- I. Projected Window Hardware:
1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E 405, Method A.
 - a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.
 2. Hinges: Stainless steel concealed four-bar adjustable friction hinges meeting AAMA 904.1, non-friction type, not less than two per sash.
 3. Locks shall be single arm roto operators with lift lock. Provide two-point locking for ventilators over 40 inches.
 - a. Standard project-out cam handle lock
 4. Limit Devices: Concealed support arms with adjustable, limited, hold-open limit devices designed to restrict sash opening.
 - a. Limit clear opening to 6 inches (150 mm) for ventilation; with custodial key release.
- J. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
1. Dual durometer PVC, neoprene, EPDM or other suitable material as tested and approved by the window manufacturer.
 2. Bulb type at exterior vent members.
 3. Securely stake and join at corners. Provide drainage to exterior as necessary.
 4. Weather-stripping shall provide an effective pressure-equalization seal at the interior face of the sash ventilator.
- K. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

- A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.
- B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- C. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
- D. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.5 INSECT SCREENS

- A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
 1. Type and Location: Full, inside for project-out sashes.
- B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
 1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
- C. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
 1. Wire-Fabric Finish: Charcoal gray.

2.6 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
 1. Bolts, screws or fastenings shall not bridge thermal barrier or impair independent frame movement.
 2. Miter corners and mechanically stake over a solid extruded aluminum corner key, leaving only hairline joinery, then seal weather tight.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

- E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.
- F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

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

2.8 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
 - 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
 - 2. Air-Infiltration Testing:
 - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
 - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
 - 3. Water-Resistance Testing:
 - a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
 - 4. Testing Extent: Three windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
 - 5. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

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

END OF SECTION 08 51 13

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SECTION 08 71 30 – DOOR HARDWARE - SCIENCE WING

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 commercial door hardware for the following:
1. Swinging doors.
 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Electromechanical door hardware.
 3. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Section 08 11 13 "Hollow Metal Doors and Frames."
 2. Section 08 14 16 "Flush Wood Doors."
 3. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts."
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 2. ICC/IBC - International Building Code.
 3. NFPA 70 - National Electrical Code.
 4. NFPA 80 - Fire Doors and Windows.
 5. NFPA 101 - Life Safety Code.
 6. NFPA 105 - Installation of Smoke Door Assemblies.
 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards:
1. ANSI/BHMA Certified Product Standards - A156 Series
 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.

- c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Section 01 77 00 "Closeout Procedures."

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

- E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- F. Keying Conference: Conduct conference to comply with requirements in Section 01 31 00 "Project Management and Coordination." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Section 01 31 00 "Project Management and Coordination" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.
 - 3. Twenty five years for manual surface door closer bodies.
 - 4. Five years for motorized electric latch retraction exit devices.
 - 5. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: 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.

PART 2 - PRODUCTS**2.1 SCHEDULED DOOR HARDWARE**

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
- C. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Sets.
- D. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'7" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following:

5. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 6. Acceptable Manufacturers:
 - a. Bommer Industries (BO).
 - b. Hager Companies (HA).
 - c. McKinney Products (MK).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Acceptable Manufacturers:
 - a. Bommer Industries (BO).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
1. Acceptable Manufacturers:
 - a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
 - b. Securitron (SU) - EL-CEPT Series.
 - c. Von Duprin (VD) - EPT-10 Series.
- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.

- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
2. Acceptable Manufacturers:
- a. McKinney Products; (MK) – QC-C Series

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years' experience designing secured master key systems and have on record a published security keying system policy.
1. Acceptable Manufacturers:
- a. Stanley Best (BE).
 - b. No Substitution.
- B. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 5. Keyway: Match Facility Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. New System: Key locks to a *new or existing key system* as directed by the Owner.
- D. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.
- F. Key Registration List (Bitting List):
1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 2. Provide transcript list in writing or electronic file as directed by the Owner.
- G. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent

markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Acceptable Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Stanley Best (BE) – 40H Series.

2.6 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

- B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.7 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 3. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 4. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
 5. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Stanley Precision (PR) - Apex 2000 Series.
- C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.
1. Provide keyed removable feature where specified in the Hardware Sets.
 2. Provide stabilizers and mounting brackets as required.
 3. Provide electrical quick connection wiring options as specified in the hardware sets.
 4. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - 700/900 Series.
 - b. Sargent Manufacturing (SA) - 980S Series.

5. Stanley Precision (PR) - 822 Series

2.8 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
 1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
 5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – DC6000 Series.
 - b. Sargent Manufacturing (SA) - 351 Series.
 - c. Norton Door Controls (NO) - 7500 Series.
 - d. Yale Locks and Hardware (YA) - 4400 Series.

2.9 SURFACE MOUNTED CLOSER HOLDERS

- A. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.
1. Acceptable Manufacturers:
 - a. Rixson (RF) - 980/990 Series.
 - b. Sargent Manufacturing (SA) - 1560 Series

2.10 ARCHITECTURAL TRIM

- A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW). Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
 3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
 4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
 5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
 6. Acceptable Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Rockwood Manufacturing (RO).
 - c. Trimco (TC).

2.11 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor

stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Acceptable Manufacturers:

- a. Burns Manufacturing (BU).
- b. Rockwood Manufacturing (RO).
- c. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Acceptable Manufacturers:

- a. Rixson Door Controls (RF).
- b. Rockwood Manufacturing (RO).
- c. Sargent Manufacturing (SA).

2.12 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: 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 UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

E. Acceptable Manufacturers:

1. National Guard Products (NG).
2. Pemko Manufacturing (PE).
3. Reese Enterprises, Inc. (RE).

2.13 ELECTRONIC ACCESSORIES

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Acceptable Manufacturers:

- a. Security Door Controls (SD) - DPS Series.
- b. Securitron (SU) - DPS Series.

- B. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Acceptable Manufacturers:

- a. Security Door Controls (SD) - 630 Series.
- b. Securitron (SU) - BPS Series.

2.14 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.15 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and 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.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."

- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DOOR HARDWARE SETS

- A. Door Hardware Sets begin on the following page.

Hardware Sets**Set: 1.0**

Doors: E100, E108

2 Continuous Hinge	CFMHD1 PT		PE
1 Removable Mullion	L980A	US28	SA
1 Rim Exit Device	LC 55 56 AD8504 862	US32D	SA <input type="checkbox"/>
1 Rim Exit Device	55 56 AD8510 862	US32D	SA <input type="checkbox"/>
1 Mortise Cylinder	1E-74	626	BE
1 Rim Cylinder	1E-72	626	BE
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
2 Gasketing	S88D		PE
1 Set Weatherstrip	by Door Manufacturer		
2 Sweep	3452AV		PE
2 ElectroLynx Harness	QC-C1500P		MK <input type="checkbox"/>
2 ElectroLynx Harness	QC-CxxP (size to door width/hardware)		MK <input type="checkbox"/>
2 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
2 Position Switch	DPS		SU <input type="checkbox"/>
1 Power Supply	per the requirements of the hardware components		SU <input type="checkbox"/>
1 CARD READER	Wall Reader to be provided by Systems Integrator		

Notes: OPENING CAN BE ACCESSED VIA VALID CREDENTIAL OR MECHANICAL KEY. ALWAYS FREE EGRESS. CONTRACTOR TO PROVIDE WIRING DIAGRAMS FOR OPENING. ALUMINUM DOOR PROVIDER WILL NEED TO COORDINATE SPECIFIED HARDWARE WITH THE STILE AND RAILS OF THE ALUMINUM DOOR TO ENSURE ADEQUATE SPACE TO INSTALL HARDWARE WITHOUT MODIFICATION TO HARDWARE OR USE OF A DROP PLATE. LINE MULLION WITH S88D GASKETING.

Set: 2.0

Doors: E103A

2 Continuous Hinge	CFMHD1		PE
2 Concealed Vert Rod Exit	NB AD8415 ETL	US32D	SA
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Set Weatherstrip	by Door Manufacturer		
1 Astragal Set	by Door Manufacturer		

USD 320 WAMEGO SCHOOL DISTRICT IMPROVEMENTS

BBN ARCHITECTS INC.

NOVEMBER 17, 2017

Set: 3.0

Doors: E103B

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2 Surface Vert Rod Exit	12 NB8715 ETL	US32D	SA
2 Door Closer	PR7500	689	NO
2 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
2 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE
1 Astragal Set	303AS (2 pc set)		PE

Set: 4.0

Doors: E104B, E106B, E109B, E112A, E112B, E113B

1 Continuous Hinge	CFMHD1		PE
1 Rim Exit Device	LC AD8504 862	US32D	SA
1 Rim Cylinder	1E-72	626	BE
1 Door Closer	CPS7500	689	NO
1 Bracket	6890	689	NO
1 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
1 Set Weatherstrip	by Door Manufacturer		
1 Sweep	3452AV		PE

Set: 5.0

Doors: E104A, E106A, E109A, E113A

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	PR7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE

Set: 6.0

Doors: E115

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
1 Gasketing	S88D		PE

Set: 7.0

Doors: E111

3 Hinge (heavy weight)	T4A3786 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	CPS7500	689	NO
1 Gasketing	S88D		PE

Set: 8.0

Doors: E105, E107, E110, E114

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Surface Overhead Stop	10-X36	630	RF
1 Surface Closer	7500 SN-134	689	NO
1 Gasketing	S88D		PE

Set: 9.0

Doors: E101

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	7500	689	NO
1 Door Stop	441	US26D	RO
1 Gasketing	S88D		PE

END OF SECTION 08 71 30

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Hardware Sets**Set: 1.0**

Doors: E100, E108

2 Continuous Hinge	CFMHD1 PT		PE
1 Removable Mullion	L980A	US28	SA
1 Rim Exit Device	LC 55 56 AD8504 862	US32D	SA <input type="checkbox"/>
1 Rim Exit Device	55 56 AD8510 862	US32D	SA <input type="checkbox"/>
1 Mortise Cylinder	1E-74	626	BE
1 Rim Cylinder	1E-72	626	BE
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
2 Gasketing	S88D		PE
1 Set Weatherstrip	by Door Manufacturer		
2 Sweep	3452AV		PE
2 ElectroLynx Harness	QC-C1500P		MK <input type="checkbox"/>
2 ElectroLynx Harness	QC-CxxP (size to door width/hardware)		MK <input type="checkbox"/>
2 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
2 Position Switch	DPS		SU <input type="checkbox"/>
1 Power Supply	per the requirements of the hardware components		SU <input type="checkbox"/>
1 CARD READER	Wall Reader to be provided by Systems Integrator		

Notes: OPENING CAN BE ACCESSED VIA VALID CREDENTIAL OR MECHANICAL KEY. ALWAYS FREE EGRESS. CONTRACTOR TO PROVIDE WIRING DIAGRAMS FOR OPENING. ALUMINUM DOOR PROVIDER WILL NEED TO COORDINATE SPECIFIED HARDWARE WITH THE STILE AND RAILS OF THE ALUMINUM DOOR TO ENSURE ADEQUATE SPACE TO INSTALL HARDWARE WITHOUT MODIFICATION TO HARDWARE OR USE OF A DROP PLATE. LINE MULLION WITH S88D GASKETING.

Set: 2.0

Doors: E103A

2 Continuous Hinge	CFMHD1		PE
2 Concealed Vert Rod Exit	NB AD8415 ETL	US32D	SA
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Set Weatherstrip	by Door Manufacturer		
1 Astragal Set	by Door Manufacturer		

USD 320 WAMEGO SCHOOL DISTRICT IMPROVEMENTS

BBN ARCHITECTS INC.

NOVEMBER 17, 2017

Set: 3.0

Doors: E103B

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2 Surface Vert Rod Exit	12 NB8715 ETL	US32D	SA
2 Door Closer	PR7500	689	NO
2 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
2 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE
1 Astragal Set	303AS (2 pc set)		PE

Set: 4.0

Doors: E104B, E106B, E109B, E112A, E112B, E113B

1 Continuous Hinge	CFMHD1		PE
1 Rim Exit Device	LC AD8504 862	US32D	SA
1 Rim Cylinder	1E-72	626	BE
1 Door Closer	CPS7500	689	NO
1 Bracket	6890	689	NO
1 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
1 Set Weatherstrip	by Door Manufacturer		
1 Sweep	3452AV		PE

Set: 5.0

Doors: E104A, E106A, E109A, E113A

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	PR7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE

Set: 6.0

Doors: E115

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
1 Gasketing	S88D		PE

Set: 7.0

Doors: E111

3 Hinge (heavy weight)	T4A3786 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	CPS7500	689	NO
1 Gasketing	S88D		PE

Set: 8.0

Doors: E105, E107, E110, E114

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Surface Overhead Stop	10-X36	630	RF
1 Surface Closer	7500 SN-134	689	NO
1 Gasketing	S88D		PE

Set: 9.0

Doors: E101

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	7500	689	NO
1 Door Stop	441	US26D	RO
1 Gasketing	S88D		PE

END OF SECTION 08 71 30

SECTION 08 71 31 – DOOR HARDWARE SETS- SCIENCE WING**Hardware Sets****Set: 1.0**

Doors: E100, E108

2 Continuous Hinge	CFMHD1 PT		PE
1 Removable Mullion	L980A	US28	SA
1 Rim Exit Device	LC 55 56 AD8504 862	US32D	SA <input type="checkbox"/>
1 Rim Exit Device	55 56 AD8510 862	US32D	SA <input type="checkbox"/>
1 Mortise Cylinder	1E-74	626	BE
1 Rim Cylinder	1E-72	626	BE
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
2 Gasketing	S88D		PE
1 Set Weatherstrip	by Door Manufacturer		
2 Sweep	3452AV		PE
2 ElectroLynx Harness	QC-C1500P		MK <input type="checkbox"/>
2 ElectroLynx Harness	QC-CxxP (size to door width/hardware)		MK <input type="checkbox"/>
2 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
2 Position Switch	DPS		SU <input type="checkbox"/>
1 Power Supply	per the requirements of the hardware components		SU <input type="checkbox"/>
1 CARD READER	Wall Reader to be provided by Systems Integrator		

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Set: 2.0

Doors: E103A

2 Continuous Hinge	CFMHD1		PE
2 Concealed Vert Rod Exit	NB AD8415 ETL	US32D	SA
2 Door Closer	CPS7500	689	NO
2 Bracket	6890	689	NO
2 Blade Stop	6891	689	NO
1 Set Weatherstrip	by Door Manufacturer		
1 Astragal Set	by Door Manufacturer		

Set: 3.0Doors: [E103B](#)

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2 Surface Vert Rod Exit	12 NB8715 ETL	US32D	SA
2 Door Closer	PR7500	689	NO
2 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
2 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE
1 Astragal Set	303AS (2 pc set)		PE

Set: 4.0Doors: [E104B](#), [E106B](#), [E109B](#), [E112A](#), [E112B](#), [E113B](#)

1 Continuous Hinge	CFMHD1		PE
1 Rim Exit Device	LC AD8504 862	US32D	SA
1 Rim Cylinder	1E-72	626	BE
1 Door Closer	CPS7500	689	NO
1 Bracket	6890	689	NO
1 Blade Stop	6891	689	NO
1 Threshold	273x3AFG		PE
1 Set Weatherstrip	by Door Manufacturer		
1 Sweep	3452AV		PE

Set: 5.0Doors: [E104A](#), [E106A](#), [E109A](#), [E113A](#)

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	PR7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Electromagnetic Holder	998 (tie into fire alarm)	689	RF □
1 Gasketing	S88D		PE

Set: 6.0Doors: [E115](#)

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Door Closer	7500	689	NO
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
1 Gasketing	S88D		PE

Set: 7.0Doors: [E111](#)

3 Hinge (heavy weight)	T4A3786 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	CPS7500	689	NO
1 Gasketing	S88D		PE

Set: 8.0

Doors: E105, E107, E110, E114

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	45H7R 15H	626	BE
1 Surface Overhead Stop	10-X36	630	RF
1 Surface Closer	7500 SN-134	689	NO
1 Gasketing	S88D		PE

Set: 9.0

Doors: E101

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	45H7D 15H	626	BE
1 Door Closer	7500	689	NO
1 Door Stop	441	US26D	RO
1 Gasketing	S88D		PE

END OF SECTION 08 71 31

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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.

1.2 SUMMARY

- A. Section includes:
 - 1. Glass for windows, doors, interior borrowed lites, and storefront framing.
 - 2. Field-applied privacy film.
 - 3. Glazing sealants and accessories.
 - 4. Fire-protection-rated glazing.**
- B. Related Requirements:
 - 1. Section 08 14 16 "Flush Wood Doors."**
 - ~~2.~~ Section 10 28 00 "Toilet and Bath Accessories" for framed mirrors.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

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

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of the following products; 12 inches (300 mm) square.
 1. Coated glass.
 2. Insulating glass.
 3. Glass film.
- C. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturers of insulating-glass units with sputter-coated, low-E coatings.
- B. Product Certificates: For glass.
- C. Product Test Reports: For coated glass insulating glass, for tests performed by a qualified testing agency.
 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: 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.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AGC Glass Company North America, Inc.
 2. Cardinal Glass Industries.
 3. Guardian Glass; SunGuard.
 4. Oldcastle BuildingEnvelope™.
 5. Pilkington North America.
 6. Vetrotech Saint-Gobain.
 7. Viracon, Inc.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Drawings.
 2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
 3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
 2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.

5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 1. Flatness Tolerances: Overall bow and warp shall not exceed 50 percent of values tabulated in ASTM C 1048.
 2. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Direction of roller wave shall be consistent throughout building.
 - a. Roller wave peak-to-valley deviation shall not exceed 0.003 inch (0.076 mm) "Peak to Valley" in the central area and 0.008 inch (0.2 mm) within 10-1/2 inches (267 mm) of the leading and trailing edge.
 - b. Tempered architectural safety glass shall conform to ANSI Z97.1 and CPSC 16 CFR 1201.
 - c. Provide heat soak testing conforming to EN14179 which includes a 2-hour dwell at 550°F ± 18°F (290°C ± 10°C).

- B. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Sputter-Coated Float Glass: Float glass with metallic-oxide or metallic-nitride coating deposited by vacuum deposition process after manufacture and heat treatment.

2.5 GLASS FILM

- A. Decorative Film Overlay: Translucent, dimensionally stable, cast PVC film, 2-mil- (0.05-mm-) minimum thickness, with pressure-sensitive, clear adhesive back for adhering to glass and releasable protective backing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Window Film
 - b. Avery Dennison Graphics
 - c. Decorative Films, LLC.
 - d. digitalFX by Reid Witlin.
 - e. FDC Graphic Films, Inc.
 - f. Llumar Decorative Films.
 - g. Madico Films.
- B. Materials: Flexible polyester materials with scratch resistant coatings.
- C. Performance Requirements:
 - 1. Scratch Resistance: Decorative films shall average less than 12 percent increase in haze when tested according to ASTM D1044 using a Teledyne Taber Abrader using CS10F Type III wheels each loaded to 0.5 kg for 100 cycles in a 70 percent vacuum.
 - a. Scratch resistance testing shall be performed by an independent third party agency.
 - 2. Surface Burning Characteristics: Provide films that have Flame Spread Index of 0 and Smoke Developed Index of 30 or less when tested in accordance with ASTM E84.
- D. Decorative Film Accessories: General: Provide accessories either manufactured by or acceptable to Decorative film manufacturer for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
 - 1. Pressure sensitive adhesive: This adhesive is activated by pressure and water. It is characterized by its permanently tacky nature and its installation ease.
 - 2. Cleaners, Primers, and Sealers: Types recommended by film manufacturer.

2.6 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 2. Perimeter Spacer: Thermally broken aluminum with black, color anodic finish.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Technoform Glass Insulation NA, Inc.
 - 2) Thermix; a brand of Ensinger USA.
 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 FIRE-PROTECTION-RATED GLAZING

- A. **Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 252 or UL 10C, including the hose-stream test, and shall comply with NFPA 80.**
- B. **Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.**
- C. **Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 5-mm thickness; faced on one surface with a clear glazing film; and complying with ANSI Z97.1 and 16 CFR 1201, Category I and II.**
1. **Basis-of-Design Product: Subject to compliance with requirements, provide Technical Glass Products; FireLite NT (D-H-NT-45) or comparable product by one of the following:**
 - a. **AGC Glass Company North America, Inc.**
 - b. **SAFTI FIRST Fire Rated Glazing Solutions.**
 - c. **Vetrotech Saint-Gobain**
 2. **Fire Rating: 45 minutes**
 3. **Approximate Visible Transmission: 88 percent.**
 4. **Approximate Visible Reflection: 9 percent.**
 5. **Hardness (Vicker's Scale): 700.**
 6. **Surface Finish: Manufacturer's standard grade.**

2.72.8 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Pecora Corporation.
 - d. Tremco Incorporated.

C. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.

- 1. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.**

2.82.9 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

2.92.10 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled indicated fire-resistant glazing product with which it is used for application and fire-protection rating**

2.102.11 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit 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.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
 - 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 (3-mm) 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.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. 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.
- K. 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.

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.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 FILM INSTALLATION

- A. Preparation:
 - 1. Clean surfaces thoroughly prior to installation.
 - 2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- B. General: Install in accordance with manufacturer's instructions.
 - 1. Cut film edges neatly and square at a uniform distance of 1/8 inch (3 mm) to 1/16 inch (1.5 mm) of window sealant.
 - 2. Spray the slip solution, composed of one capful of baby shampoo or dishwashing liquid to 1 gallon of water, on window glass and adhesive to facilitate proper positioning of film.
 - 3. Apply film to glass and lightly spray film with slip solution.
 - 4. Squeegee from top to bottom of window. Spray slip solution to film and squeegee a second time.
 - 5. Remove air bubbles, blisters, and other defects.
 - 6. Upon completion of film application, allow 30 days for moisture from film installation to dry thoroughly, and to allow film to dry flat with no moisture dimples when viewed under normal viewing conditions.
- C. Decorative Film Overlay: Apply squarely aligned to glass edges, uniformly smooth, and free from tears, air bubbles, wrinkles, and rough edges, in single sheet completely overlaying with graphic image as indicated on Drawings to the back face of clean glass, according to manufacturer's written instructions, including surface preparation and application temperature limitations.

3.8 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry

surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces 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.

3.9 MONOLITHIC INTERIOR GLASS SCHEDULE

- A. Glass Type 3: Clear heat-strengthened float glass.
1. Minimum Thickness: 6 mm.
- B. Glass Type 4: Clear fully tempered float glass.
1. Minimum Thickness: 6 mm.
 2. Safety glazing required.
- C. Heat Treated Monolithic-Glass: Provide clear heat-strengthened float glass or fully tempered float glass where full tempering is required to resist thermal stresses induced by differential

3.10 MONOLITHIC INTERIOR FILM OVERLAY GLASS SCHEDULE

- A. Glass Type GL-5: Glass with decorative film overlay.
1. Glass Type: Clear, heat-strengthened or fully tempered float glass.
 2. Glass Thickness: 6.0 mm.
 3. Use: Suitable for interior applications.
 4. Pattern: As selected by Architect from manufacturer's full range.

3.11 INSULATING GLASS SCHEDULE

- A. Glass Type 1 (Item 8.6): Low-E Coated Clear Insulating Glass with Fully Tempered Lites:
1. Basis-of-Design Product: Viracon, Solarscreen 2000 VE 1-2M.
 2. Overall Unit Thickness: 1 inch (25 mm).
 3. Minimum Thickness of Each Glass Lite: 6 mm.
 4. Indoor Lite: Fully tempered float glass.
 5. Interspace Content: Argon.
 6. Outdoor Lite: Fully tempered float glass.
 7. Low-E Coating: Sputtered on second surface.
 8. Winter Nighttime U-Factor: 0.25 maximum.

9. Summer Daytime U-Factor: 0.21 maximum.
10. Visible Light Transmittance: 70 percent minimum.
11. Solar Heat Gain Coefficient: 0.37 maximum.
12. Shading coefficient: 0.43.
13. Relative heat gain: 89 BTU per hour per square foot.
14. Light to solar gain ratio (LSG): 1.9.
15. Safety glazing required for indoor lite.
16. Sealing system: Dual seal, with manufacturer's standard primary and secondary seals
17. Spacer: Thermoset structural silicone foam
18. Desiccant: Molecular sieve or silica gel, or blend of both.
19. IGCC certification: Level CBA.
20. Provide insulating glass units permanently marked either on spacers or on at least one component lite of units with certification label of IGCC.

B. Glass Type 2 (Item 8.xx6): Low-E Coated Clear Insulating Glass with Heat Strengthened Lites:

1. Basis-of-Design Product: Viracon, Solarscreen 2000 VE 1-2M.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Indoor Lite: Heat strengthened float glass.
5. Interspace Content: Argon.
6. Outdoor Lite: Heat strengthened float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Summer Daytime U-Factor: 0.21 maximum.
10. Visible Light Transmittance: 70 percent minimum.
11. Solar Heat Gain Coefficient: 0.37 maximum.
12. Shading coefficient: 0.43.
13. Relative heat gain: 89 BTU per hour per square foot.
14. Light to solar gain ratio (LSG): 1.9.
15. Safety glazing required for indoor lite.
16. Sealing system: Dual seal, with manufacturer's standard primary and secondary seals
17. Spacer: Thermoset structural silicone foam
18. Desiccant: Molecular sieve or silica gel, or blend of both.
19. IGCC certification: Level CBA.
20. Provide insulating glass units permanently marked either on spacers or on at least one component lite of units with certification label of IGCC.

END OF SECTION 08 80 00

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

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. Gypsum Board Systems:
 - 1. Interior walls, partitions, and ceilings for tape and joint compound finish.
 - 2. Steel framing systems to receive gypsum board.
 - 3. Sound reduction membrane in gypsum drywall systems.
 - 4. Suspension systems for interior ceilings.

1.3 DEFINITIONS

- A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Studs and Runners: Provide documentation that framing members' certification is according to SIFA's "Code Compliance Certification Program for Cold-Formed Steel Structural and Non-Structural Framing Members."

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
- B. Qualification Data: For finisher.

1.6 QUALITY ASSURANCE

- A. Finisher Qualifications: Minimum three years' experience in executing Level 5 finish in accordance with GA-214.
- B. Mockups for the following:

1. Levels of gypsum board finish for use in exposed locations.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance: Fire and structural meeting requirements of building code and local authorities.
- B. 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.
- 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. Horizontal Deflection: For wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

2.2 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation; ProRoc Type X.
 - b. Georgia-Pacific Building Products; "DensArmor Plus Fireguard."

- c. National Gypsum Company; Gold Bond Brand Fire-Shield Wallboard.
 - d. United States Gypsum Company; USG Sheetrock® Brand Firecode® X Gypsum Panels.
 2. Thickness: 5/8 inch (15.9 mm).
 3. Long Edges: Tapered.
- B. Mold and Mildew Resistant Gypsum Board: ASTM C 1396/C 1396M with moisture- and mold-resistant core and surfaces.
 1. Product: Subject to compliance with requirements, provide one of the following or an approved equal:
 - a. CertainTeed Corporation, M2Tech Moisture & Mold Resistant, Type X.
 - b. Georgia-Pacific Gypsum LLC, "DensArmor Plus, Fireguard Panels.
 - c. National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board.
 - d. USG Corporation, Sheetrock Brand Mold Tough AR Firecode (Type X).
 2. Core: 5/8 inch (15.9 mm), Type X.
 3. Long Edges: Tapered.
 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 5. Location: Above first course of dry interior gypsum board corridor partitions and all partitions in general use areas.
- C. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation; Extreme Impact Resistant Gypsum Board with M2Tech.
 - b. Georgia-Pacific Building Products; DensArmor Plus Fireguard Impact-Resistant Interior Panel.
 - c. National Gypsum Company; Hi-Impact Brand XP Fire-Shield Wallboard.
 - d. USG Corporation; USG Sheetrock® Brand Mold Tough® VHI (Very High Impact) Firecode® Core.
 2. Core: 5/8 inch (15.9 mm), Type X.
 3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 6. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
 7. Long Edges: Tapered.
 8. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation; ProRoc Interior Ceiling.

- b. Georgia-Pacific Building Products; DensArmor Plus High-Performance Interior Panel, Type C.
 - c. National Gypsum Company; High Strength Brand Ceiling Board.
 - d. United States Gypsum Company; Sheetrock Gypsum Panels.
2. Thickness: 1/2 inch (12.7 mm).
 3. Long Edges: Tapered.

2.3 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645.
 1. Steel Studs and Runners:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) MBA Building Supplies.
 - 3) Steel Network, Inc. (The).
 - b. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
 - c. Depth: As indicated on Drawings.
- C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CEMCO; California Expanded Metal Products Co.
 - b. ClarkDietrich Building Systems.
 - c. Steel Network, Inc. (The).
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ClarkDietrich Building Systems.
- E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ClarkDietrich Building Systems.
 2. Depth: 1-1/2 inches (38 mm).
 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ClarkDietrich Building Systems.
 2. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
 3. Depth: As indicated on the Drawings.
- G. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ClarkDietrich Building Systems.
- H. Column and Beam Drywall Clips: Clips for attachment to flanges of beams and columns for installation of gypsum board panels to provide fireproofing; galvanized steel.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Grabber Construction Products.
 2. Minimum Base-Metal Thickness: 0.025 inch (0.63 mm).
 3. Depth: 2 inches (51 mm).
 4. Width: 2-3/8 inches (60 mm)
 5. Height: 2 inches (51 mm)

2.4 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: 2 inches (51 mm).
- D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0329 inch (0.836 mm).
 - b. Depth: 2-1/2 inches (64 mm).
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Chicago Metallic Corporation.
 - c. United States Gypsum Company.

2.5 TRIM ACCESSORIES

- A. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Basis-of-Design Products: Subject to compliance with requirements, provide specified Fry Reglet Corporation products or comparable products by one of the following:
 - a. Gordon, Inc.
 - b. Pittcon Industries.
 2. Shapes:
 - a. Cornerbead: Corner Trim.
 - b. Reveal: "F" Reveal.
 - c. Molding: "J" Molding
 - d. Control Joint: 2-piece Drywall Control Joint.
 3. Dimensions: As indicated on the Drawings.
 4. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
 5. Finish: Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.6 JOINT TREATMENT MATERIALS

- A. General: Provide joint treatment materials complying with ASTM C 475/C 475M and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

- B. Joint Tape for Gypsum Board: Pressure-sensitive or staple-attached, open-weave, glass-fiber reinforcing tape with setting-type joint compound.
- C. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
 - 1. Ready-Mixed Formulation: Factory-mixed product.
 - a. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
 - b. Topping compound formulated for fill (second) and finish (third) coats.
 - c. All-purpose compound formulated for both taping and topping compounds.

2.7 ACOUSTICAL MATERIALS

- A. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- B. Sound Reduction Membrane: Flexible acoustical recycled grade polymer sheet sound barrier.
 - 1. Basis-of-Design Products: Subject to compliance with requirements, provide Imetco WaveBlok SW or comparable products by another manufacturer.
 - a. Thickness: 1/8 inch (3 mm).
 - b. Weight: 1 lb/sq. ft. (4.88 kg/sq. m).
 - 2. Product Performance:
 - a. Sound Transmission: Minimum STC of 53 over steel framing.
 - b. Fire Rating: Class 1 according to ASTM E84 when installed behind specified gypsum board.
 - c. Mold and Mildew Resistance: No visible growth according to ASTM D 3273 and ASTM G21.
- C. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- D. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - c. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.8 MISCELLANEOUS MATERIALS

- A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
- B. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum panels to steel framing.
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
 - 3. For fastening sound reduction membrane, use flat-head or truss-head screws in sizes recommended by mesh manufacturer.
- D. Isolation Strip at Exterior Walls: Provide the following:
 - 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.
- E. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 FRAMING INSTALLATION, GENERAL

- A. General: Comply with ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.
 1. Where building structure abuts ceiling perimeter or penetrates ceiling.
 2. Where partition framing and wall furring abut structure, except at floor.
 - a. Provide slip- or cushioned-type joints as detailed to attain lateral support and avoid axial loading.
 - b. Install deflection track top runner to attain lateral support and avoid axial loading.
 - c. Install deflection and firestop track top runner at fire-resistance-rated assemblies where indicated.
 - 1) Attach jamb studs at openings to tracks using manufacturer's standard stud clip.
- F. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING STEEL FRAMING FOR SUSPENDED AND FURRED CEILINGS

- A. Suspend ceiling hangers from building 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 structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.

5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Sway-brace suspended steel framing with hangers used for support.
- C. Install suspended steel framing components in sizes and at spacings indicated, but not less than that required by the referenced steel framing installation standard.
 1. Wire Hangers: 48 inches (1219 mm) o.c.
 2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
 3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.
- D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- E. Installation Tolerances: Install steel framing components for suspended ceilings so that cross-furring or grid suspension members are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) as measured both lengthwise on each member and transversely between parallel members.

3.5 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

- A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.
 1. Where studs are installed directly against exterior walls, install foam gaskets.
- B. Installation Tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
- D. Install steel studs and furring in sizes and at spacings indicated.
 1. Single-Layer Construction: Space studs 16 inches (406 mm) o.c., unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-219, and with applicable published recommendations of gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 1. Install 2 studs at each jamb, unless otherwise indicated.
 2. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

- G. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.

3.6 INSTALLING SOUND REDUCTION MEMBRANE

- A. Sound Reduction Membrane: Install on face of steel studs and on bottom chord of wood trusses in areas indicated on the Drawings and in accordance with manufacturer's recommendations and the following:
 - 1. Install membrane to the face of steel studs at no less than 12 inches (300 mm) on center vertically. Stagger or butt edges of membrane on face of steel studs.
 - 2. Install membrane vertically on steel studs.
 - 3. Seal seams with manufacturers recommended sealing tape.

3.7 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

- A. Gypsum Board: Comply with ASTM C 840 and GA-216.
- B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Form control and expansion joints with space between edges of adjoining gypsum panels.
- I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.
 - 1. Except where 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. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4 to 9.5-mm) wide joints to install sealant.
- J. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4 to 1/2-inch (6.4 to 12.7-mm) wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- K. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion 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 manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
- L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
 1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications.
- M. Space fasteners in panels that are tile substrates a maximum of 8 inches (203.2 mm) o.c.

3.8 GYPSUM BOARD APPLICATION METHODS

- A. Single-Layer Application: Install gypsum wallboard panels as follows:
 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.9 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install where indicated to receive tile. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.

- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.10 INSTALLING TRIM ACCESSORIES

- A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.
- B. Install cornerbead at external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
 - 1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 - 2. Install L-bead where edge trim can only be installed after gypsum panels are installed.
 - 3. Install U-bead where indicated.
- D. Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect; except, that in no case shall control joints in ceilings, soffits, or partitions be spaced at distance greater than 30" - 0" (9 m).
- E. Aluminum Trim: Install in locations indicated on Drawings.

3.11 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
- B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.
- C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.
- D. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by trim accessory manufacturer.
- E. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.

3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.
4. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface of the following:
 - a. Partitions with continuous, unbroken length of 20 feet.
 - b. Horizontal and vertical surfaces of soffits.

3.12 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 21 16

SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.

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-system members.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
 - 5. Size and location of initial access modules for acoustical panels.
 - 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.

- b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
- 7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
 - 8. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
 - D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

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

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 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: Class A according to ASTM E 1264.
 2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL PANELS

- A. Basis-of-Design Product (ACP-1): Subject to compliance with requirements, provide Armstrong World Industries, Inc Georgian High Washability, Item 794, or comparable product by one of the following:
1. CertainTeed Corporation.
 2. Chicago Metallic Corporation.
 3. USG Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
 2. Pattern: CE (perforated, small holes and lightly textured).
- D. Color: White.
- E. Light Reflectance (LR): Not less than 0.88.
- F. Ceiling Attenuation Class (CAC): Not less than 33.
- G. Edge/Joint Detail: Square.
- H. Thickness: 5/8 inch (15 mm).
- I. Modular Size: 24 by 24 inches (610 by 610 mm).
- J. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation 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, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc Prelude ML or comparable product by one of the following:
1. CertainTeed Corporation.
 2. Chicago Metallic Corporation.
 3. USG Corporation.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.
- C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
 2. End Condition of Cross Runners: Butt-edge type.
 3. Face Design: Flat, flush.
 4. Cap Material: Cold-rolled steel.
 5. Cap Finish: Painted white.

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.
1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.

4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch- (3.5-mm-) diameter wire.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc compatible products or comparable products by one of the following:
 1. CertainTeed Corporation.
 2. Chicago Metallic Corporation.
 3. USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel 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 acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure 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.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 7. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 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 (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 CLEANING

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

END OF SECTION 09 51 13

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SECTION 09 65 16 - RESILIENT SHEET 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl sheet flooring with backing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient sheet flooring.
 - 1. Include sheet flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
- D. Welded-Seam Samples: For seamless-installation technique indicated and for each resilient sheet flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Resilient Sheet Flooring: Furnish not less than 10 linear feet (3 linear m) Insert dimension for every 500 linear feet (150 linear m) or fraction thereof, in roll form and in full roll width for each type, color, and pattern of flooring installed.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color, and pattern in locations directed by Architect.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store rolls upright.

1.9 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive resilient sheet flooring during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.

- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during resilient sheet flooring installation.
- D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.
- E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL SHEET FLOORING WITH BACKING (SV)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. DecoArt Corlon or comparable product by one of the following:
 - 1. Forbo Industries, Inc.
 - 2. Mannington Mills, Inc.
 - 3. Shaw Contract Group; a Berkshire Hathaway company.
- B. Product Standard: ASTM F 1303.
 - 1. Type (Binder Content): Type II, minimum binder content of 34 percent.
 - 2. Wear-Layer Thickness: Grade 1.
 - 3. Overall Thickness: As standard with manufacturer.
 - 4. Backing Class: Class A (fibrous).
- C. Wearing Surface: Embossed.
- D. Sheet Width: As standard with manufacturer.
- E. Seamless-Installation Method: Heat welded.
- F. Colors and Patterns: As selected by the Architect from manufacturer's full range of colors and textures.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
- C. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Colors: Match flooring.
- D. Integral-Flash-Cove-Base Accessories:
 - 1. Cove Strip: 1-inch (25-mm) radius provided or approved by resilient sheet flooring manufacturer.
 - 2. Cap Strip: Tapered vinyl cap provided or approved by resilient sheet flooring manufacturer.
 - 3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.
- E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient sheet flooring.
- B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.
- C. Lay out resilient sheet flooring as follows:
 1. Maintain uniformity of flooring direction.
 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in flooring substrates.
 3. Match edges of flooring for color shading at seams.
 4. Avoid cross seams.
- D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
- J. Integral-Flash-Cove Base: Cove resilient sheet flooring 6 inches (152 mm) up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.
- B. Perform the following operations immediately after completing resilient sheet flooring installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.
 - 1. Apply floor polish as recommended by the manufacturer.
- E. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION 09 65 16

SECTION 09 84 23 - FABRIC WRAPPED SOUND-ABSORBING PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 - 1. Back-mounted acoustical wall panels
- B. Related Requirements:
 - 1. Section 09 84 33 "Sound-Absorbing Wall Units" for cementitious wood fiber plank acoustical wall panel system.

1.3 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.
- B. SAA: Sound Absorption Average.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include fabric facing, panel edge, core material, and mounting indicated.
- B. Shop Drawings: For unit assembly and installation.
 - 1. Include plans, elevations, sections, and mounting devices and details.
 - 2. Include details at panel head, base, joints, and corners. Indicate panel edge profile and core materials.
 - 3. Include direction of fabric weave and pattern matching.
- C. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of hardware and accessories involving color or finish selection.
- D. Samples for Verification: For the following products:
1. Fabric: Full-width by approximately 36-inch- (900-mm-) long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
 2. Panel Edge: 12-inch- (300-mm-) long Sample(s) showing each edge profile, corner, and finish.
 3. Core Material: 12-inch- (300-mm-) square Sample at corner.
 4. Mounting Devices: Full-size Samples.
 5. Assembled Panels: Approximately 36 by 36 inches (900 by 900 mm), including joints and mounting methods.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Electrical outlets, switches, and thermostats.
 2. Items penetrating or covered by units including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Alarms.
- B. Product Certificates: For each type of unit.
- C. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 sq. yd. (9 sq. m), full width of bolt.
 2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
- C. Store products in manufacturer's unopened packaging until ready for installation.
 - 1. Store materials flat, in dry, well-ventilated space.
 - 2. Do not stand panels on end.
 - 3. Protect edges from damage.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.
- C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Acoustical performance.
 - b. Fabric sagging, distorting, or releasing from panel edge.
 - c. Warping of core.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.2 SOUND-ABSORBING WALL UNITS

- A. Sound-Absorbing Wall Panel: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed core and bonded or attached to edges and back of frame.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Golterman & Sabo; Acoustic-Tack Fiberglass Panels (ATF) or comparable product by one of the following:
 - a. Acoustical Solutions, Inc.
 - b. Armstrong World Industries, Inc.
 - c. Conwed Designscape; an Owens Corning company.
 - d. MBI Products Company, Inc.
 - e. Panel Solutions, Inc.
 - f. Proudfoot Company, Inc. (The).
 2. Mounting: Back mounted with manufacturer's standard two-part Z-clips, secured to substrate.
 3. Core: Glass-fiber board.
 - a. Core-Face Layer: Manufacturer's standard tackable, impact-resistant, high-density board.
 4. Edge Construction: Manufacturer's standard chemically hardened facing sheet with no frame.
 5. Edge Profile: Square.
 6. Corner Detail in Elevation: Square with continuous edge profile indicated.
 7. Acoustical Performance: Sound absorption NRC of 0.75 to 1.00 according to ASTM C 423 for Type A mounting according to ASTM E 795.
 8. Nominal Core Thickness: 1 inch (25 mm).
 9. Panel Dimensions: As indicated on Drawings.

2.3 MATERIALS

- A. Core Materials:
 1. Glass-Fiber Board: ASTM C 612; of type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m), unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2. Tackable, Impact-Resistant, High-Density Board for Face Layer: 1/8-inch- (3.2-mm-) thick layer of compressed molded glass-fiber board with a nominal density of 16 to 18 lb/cu. ft. (256 to 288 kg/cu. m) laminated to face of core.
- B. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations.
1. Manufacturer: Guilford of Maine.
 2. Product Line/Pattern: FR701 2100.
 3. Pattern Repeat: None.
 4. Color: Claret Accent 418
 5. Fiber Content: 100 percent woven polyester.
 6. Width: 66 inches (1676 mm).
 7. Applied Treatments: Stain resistance and flame retardant.
- C. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
1. Two-Part Metal Z-Clips: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.4 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Edge Hardening: For glass-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.
- C. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.
- D. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
1. Square Corners: Tailor corners.
 2. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.
- E. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:
1. Thickness.
 2. Edge straightness.
 3. Overall length and width.
 4. Squareness from corner to corner.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Two-Part Z-Clips: Fasten bars to wall at 48 inches (1220 mm) on center in both directions. Impale matching mechanical clips into back of panels in matching pattern and drop panel into position so clips fully engage into wall-mounted bars.
 - 1. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- C. Align fabric pattern and grain with adjacent units.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus 1/16 inch (1.6 mm) in 48 inches (1200 mm), noncumulative.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 09 84 23

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations for Field Applied Systems: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.
 - 1. Applicator shall verify compatibility of field applied materials with shop applied primers. Application of finish coat establishes acceptance of primed surfaces.
- C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project. Comply with procedures specified in Painting and Decorating Contractors of America (PDCA) P5. Duplicate finish of approved Samples.
 - 1. Surface-Preparation Mockups: On existing surfaces using applicable specified methods of cleaning and other surface preparation, provide mockup sample of at least 10 sq. ft. (0.9 sq. m).
 - 2. Painting Benchmarks: Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.
 - a. Wall Surfaces: Provide samples on at least 100 square feet (9 sq. m).
 - b. Small Areas and Items: Architect will designate an item or area required.

3. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to the Schedule or as specified. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
5. Final approval of colors will be from benchmark samples.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
 8. Volatile Organic Content (VOC).
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.8 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

- A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

2.2 PAINT COLORS

- A. Basis-of-Design Colors: The design is based on the colors indicated by manufacturer's designations in the Finish Schedule Legend. Subject to compliance with requirements, provide exact duplicates of the named colors.

2.3 PAINT MATERIALS

- A. Basis-of-Design Products: The design for each type of paint is based on the products named. Subject to compliance with requirements, provide either the named products or comparable products by one of the following:
1. Benjamin Moore & Co.
 2. PPG Industries, Inc.
 3. Sherwin-Williams Co.
 4. Tnemec, Inc.
- B. Primers:
1. Multi-Purpose Interior/Exterior Latex Primer/Sealer: Sherwin Williams, "B51-450 Series."
 2. Latex Block Filler: Sherwin Williams, "PrepRite Block Filler"
 3. Miscellaneous Metals and Steel Rust Inhibiting Primer: Sherwin-Williams "Pro-Industrial B66-310 Series.
 4. Galvanized Steel and Non-Ferrous Metal Primer: Sherwin Williams: "Macropoxy 646-Fast Cure Epoxy, B58-600/B58V600."
 5. Organic Zinc Rich Primer: Sherwin Williams "Zinc-Clad IIIHS";
- C. Exterior intermediate Paint Materials:
1. High Build Polyamide Epoxy, Sherwin Williams "Recoatable Epoxy Primer."
- D. Exterior Finish Paint Materials:

1. Semi-Gloss Acrylic Polymer: Sherwin Williams, "Sher-Cryl HPA, B66-350."
2. Semi-Gloss Aliphatic Acrylic Polyurethane: Sherwin Williams, "Hi-Solids Polyurethane 100, B65-630."

2.4 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 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 surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 1. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections under which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 1. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.
- C. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry: 12 percent.
 4. Wood: 15 percent.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 1. SSPC-SP 7/NACE No. 4.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.

2. Sand surfaces that will be exposed to view, and dust off.
 3. Prime edges, ends, faces, undersides, and backsides of wood.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain paint before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 4. Paint entire exposed surface of window frames and sashes.
 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.
 - a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.

- b. Brush out and work brush coats into surfaces in an even film.
 - c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
 3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.
 - a. Use airless or air-assisted spray equipment with orifice size recommended by manufacturer for material and texture required.
 - b. Apply each coat to provide the equivalent hiding of brush-applied coats.
 - c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.
- F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer. Finish coats shall be provided in the dry film thickness specified in the schedules located at the end of this Section.
- G. Mechanical items to be painted include, but are not limited to, the following:
 1. Uninsulated metal piping.
 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, without liner, behind air inlets and outlets.
 6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
 7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
- H. Electrical items to be painted include, but are not limited to, the following:
 1. Switchgear.
 2. Panelboards.
 3. Electrical equipment that is indicated to have a factory-primed finish for field painting.
- I. Block Fillers: Apply block fillers to concrete masonry and cast-in-place concrete at a rate to ensure complete coverage with all pores filled.
- J. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to substrates that are required to be painted or finished and that have not been prime coated by others.
 1. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holi-

days, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

1. Apply additional coats as required to provide a completely opaque and uniform finish surface.
 2. Deep and accent clear-base colors may require 1-2 more coats to achieve the proper hide
- L. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
1. Provide satin finish for final coats.
- M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 SHOP APPLIED METAL PRIMER SCHEDULE

- A. General: Provide the following paint system for the various substrates indicated.
- B. Structural Steel Framing:
1. Primer: Organic zinc rich primer (3 mils)

- C. Non-Galvanized Ferrous Metal Shapes and Plates:
 - 1. Primer: Rust Inhibiting Primer (3 mils)
- D. Galvanized Surfaces, including Railings and Miscellaneous Shapes and Plates:
 - 1. Primer: Galvanized Steel and Non-Ferrous Metal Primer (4 mils)

3.7 EXTERIOR PAINT SCHEDULE

- A. General: Provide the following paint system for the various substrates indicated.
- B. Non-Galvanized and Shop-Primed Ferrous Metal (Including Hollow Metal Doors):
 - 1. Acrylic: Three coats
 - a. Primer: Rust Inhibiting Primer (Primer is not required on shop primed items. Shop primer may require field touchup.)
 - b. First Coat: Semi-Gloss Acrylic Polymer (3 mils)
 - c. Second Coat: Semi-Gloss Acrylic Polymer (3 mils)
- C. Aluminum and Galvanized Sheet Metal:
 - 1. Acrylic: Three coats
 - a. Primer: Galvanized Steel and Non-Ferrous Metal Primer
 - b. First Coat: Semi-Gloss Acrylic Polymer (3 mils)
 - c. Second Coat: Semi-Gloss Acrylic Polymer (3 mils)
- D. Galvanized Miscellaneous Shapes and Plates:
 - 1. Polyurethane Finish: Two coats
 - a. Primer: Galvanized Steel and Non-Ferrous Metal Primer (4 mils)
 - b. Finish Coat: Semi-Gloss Aliphatic Acrylic Polyurethane (4 mils)
- E. Shop Primed Structural Steel and Railings: Miscellaneous Shapes and Plates with Organic Zinc Rich Primer:
 - 1. Polyurethane Finish: Two coats
 - a. Intermediate: Intermediate for Shop Primed Structural Steel (6 mils)
 - b. Finish Coat: Semi-Gloss Aliphatic Acrylic Polyurethane (4 mils)

END OF SECTION 09 91 13

SECTION 10 28 00 - 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Washroom and shower accessories.
 - 2. Childcare accessories.
 - 3. Underlavatory guards.
 - 4. Custodial accessories.

1.3 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. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Samples: Full size, for each exposed product and for each finish specified.
 - 1. 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.
 - 1. Identify locations using room designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS**2.1 OWNER-FURNISHED MATERIALS**

- A. Owner-Furnished Equipment: The Owner will provide the following items to the Contractor for installation:
1. Liquid-Soap Dispenser.
 2. Paper Towel Dispenser.
 3. Toilet Tissue Dispenser.
 4. Sanitary Napkin Dispenser.
 5. Waste Receptacles.

2.2 WASHROOM AND SHOWER ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Basis-of-Design Products: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
1. A & J Washroom Accessories, Inc.
 2. American Specialties, Inc.
 3. Bobrick Washroom Equipment, Inc.
 4. Bradley Corporation.
 5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
- C. Grab Bars: Horizontal Straight Line:
1. Basis-of-Design Product: Bobrick Model B-6806.99.
 2. Mounting: Flanges with concealed fasteners.
 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
 4. Outside Diameter: 1-1/2 inches (38 mm).
 5. Lengths: As indicated on Drawings.

D. Grab Bars: Horizontal Two-Wall Shower:

1. Basis-of-Design Product: Bobrick Model B-6861.99.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/2 inches (38 mm).
5. Lengths: As indicated on Drawings.

E. Grab Bars: Horizontal Two-Wall Wheelchair Toilet Compartment:

1. Basis-of-Design Product: Bobrick Model B-68137.99.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/2 inches (38 mm).
5. Lengths: As indicated on Drawings.

F. Sanitary-Napkin Disposal Unit, Dual Access:

1. Basis-of-Design Product: Bobrick Model B-354.
2. Mounting: Partition mounted, dual access.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

G. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product: Bobrick Model B-254.
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

H. Shelf:

1. Basis-of-Design Product: Bobrick Model B-295
2. Description: With exposed edges turned down not less than 1/2 inch (13 mm) and supported by two triangular brackets welded to shelf underside.
3. Size: 24 inches (610 mm) long by 5 inches (125 mm) deep.
4. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).

I. Mirror Units:

1. Basis-of-Design Product: Bobrick Model B-290 2430 and B-290 2470.
2. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick.

- a. Corners: Welded and ground smooth.
 3. Integral Shelf: 5 inches (127 mm) deep.
 4. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
 5. Sizes:
 - a. Over Lavatories: 24 by 30 inches (610 by 760 mm).
 - b. Full Length: 24 by 72 inches (610 by 1830 mm).
- J. Coat Hook:
1. Basis-of-Design Product: Bobrick Model B-677
 2. Description: Single-prong unit.
 3. Material and Finish: Stainless steel, No. 4 finish (satin).
- K. Diaper-Changing Station:
1. Basis-of-Design Product: Bobrick Koala Kare Model KB110-SSRE
 2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of 250-lb (113-kg) static load when opened.
 3. Mounting: Semirecessed, with unit projecting not more than 1 inch (25 mm) from wall when closed.
 4. Operation: By pneumatic shock-absorbing mechanism.
 5. Material and Finish: Stainless steel, No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners.
 6. Liner Dispenser: Built in.
- L. Shower Curtain Rod:
1. Basis-of-Design Product: Bobrick Model B-6047.
 2. Description: 1-1/4-inch (32-mm) OD; fabricated from nominal 0.05-inch- (1.3-mm-) thick stainless steel.
 3. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
 4. Finish: Stainless steel, No. 4 finish (satin).
- M. Shower Curtain:
1. Basis-of-Design Product: Bobrick Model 204-2 with 204-1 Curtain Hooks.
 2. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1828 mm) high.
 3. Material: Vinyl, minimum 0.008 inch (0.2 mm) thick, opaque, matte.
 4. Color: White.

5. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

N. Robe/Clothes Hook:

1. Basis-of-Design Product: Bobrick Model B-2116
2. Description: Single-prong unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Materials Subject to compliance with requirements, provide product by one of the following:
 - a. Plumberex Specialty Products, Inc.
 - b. Truebro by IPS Corporation.
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

2.4 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Mop and Broom Holder with Shelf:

1. Basis-of-Design Product: Bobrick Model B-239 x 34
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 34 inches (865 mm).
4. Hooks: Four.
5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.

2.5 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

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

END OF SECTION 10 28 00

SECTION 115313 – LABORATORY FUME HOODS AND RELATED PRODUCTS

Labconco Protector Premiere fume hood 100400040-27338 4 ft fume hood with guardian monitor and GFCI duplex factory installed flush mount, with worksurface 9500400, base stand 3746702, 2 ft acid cabinet Right hinge 9901500, Acid Vent kit 3591100, 2 ft solvent cabinet Left hinge 9902400, solvent vent kit 9910000, and 2 ea 3909900 dished epoxy tops for acid and solvent side elevation mounting,

PART 1 - GENERAL**1.1 SUMMARY****A. Section Includes:**

1. Bench-top High-Performance Laboratory Fume Hoods with Integral Blower.
2. Service fixtures (ie. water, gas, etc.) and electrical service fittings in fume hoods.
3. Piping and wiring within service fittings, light fixtures, switches, and other electrical devices.
4. Fume hood base support.
5. Work Surfaces within fume hoods.
6. Laboratory sinks and cup sinks in fume hoods.
7. Filler panels and ceiling enclosures for fume hoods.

B. Related Sections:

1. Section 238500: Furnishing and installation of exhaust duct work and equipment, and final connection of hoods.
2. Section 260100: Furnishing and installation of electrical utilities and final connections to hoods.

1.2 SCOPE AND CLASSIFICATION

- A. This specification covers the requirements for the purchase of bench-mounted fiberglass-lined laboratory fume hoods with integral blower systems.
- B. Bench-mounted laboratory fume hoods in 4, 5, and 6-foot widths, internal depth of 23.3" and external depth of 31.7" is required.
- C. This specification sets the intent for quality, performance and appearance.

1.3 REFERENCES**A. The laboratory hoods must conform to the following regulations and standards.**

1. SEFA 1-2010, Scientific Equipment and Furniture Association , Recommended Practices for Laboratory Fume Hoods
2. SEFA 8-2010, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests
3. NFPA 45-2011, National Fire Protection Association, Fire Protection for Laboratories Using Chemicals
4. ASTM E84-09C, ANSI 2.5, NFPA 255, UL 723, UBC 8-1 (42-1), Standard Test method for Surface Burning Characteristics of Building Materials
5. ASHRAE 110-2016, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Method of Testing Performance of Laboratory Fume Hoods
6. OSHA, Federal Register 29 CFR Part 1910, Occupational Safety & Health Administration, U.S. Department of Labor, Occupational exposures to hazardous chemicals in laboratories.

- B. The laboratory fume hoods must carry the ETL listed mark for the following.
1. UL 61010-1 (formerly 3101-1), Underwriters Laboratories Inc., Electrical Equipment for Laboratory Use
 2. CAN/CSA C22.2 No. 61010-1, Canadian Standards Association, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
 3. UL 1805, Underwriters Laboratories Inc., Standard for Laboratory Hoods and Cabinets

1.4 PERFORMANCE REQUIREMENTS

- A. General Design Requirements (See Part 2 for details)
1. Fume hoods shall function as ventilated, enclosed workspaces, designed to capture, contain and exhaust fumes, vapors and particulate matter produced or generated within the enclosure.
 2. Fume hood shall be factory designed to function as a by-pass, constant volume fume hood.
 3. Structure and Materials of construction
 - a. Hoods are of double-wall construction
 - b. Powder-coated, cold rolled steel exterior
 - c. Galvanized steel support members
 - d. One-piece, monolithic, molded polyester resin liner
 4. Baffles
 - a. One-piece, monolithic, molded polyester resin
 - b. Moving or adjustable baffles are not acceptable
 5. Sash
 - a. Maximum opening is 28".
 - b. Unobstructed viewing height is 37.5".
 - c. Hood incorporates a perforated sash handle to bleed air into the hood chamber directing fume concentrations away from the user's breathing zone.
 6. Airfoil:
 - a. Hoods are provided with an air foil across the bottom of the sash area to allow airflow into the hood regardless of user's position.
 7. Besides the exhaust blower, no additional blowers are required for specified containment.
 8. Access for maintenance is from both the front and exterior sides of the hood, as lift off panels with no tool / fastener removal required.
 9. Services:
 - a. Factory install all electrical receptacle, airflow monitor, and switches, as listed in these specifications, equipment schedules or as shown on drawings.
 - b. Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed per section 2.03.
 - c. Final plumbing and electrical connections are the responsibility of those contractors fulfilling requirements of Divisions 230000 and 260000.
120 V, 20 amp GFCI electrical services and air flow alarm monitor are pre-wired to a single point internal junction box at the top right of the hood (on vapor proof models only).
 10. Hoods without service fixtures pass through a 33" opening without disassembly.
 11. Exhaust Blower
 - a. Integral blower shall be belt-driven, corrosion resistant with adjustable sheave, molded thermoplastic housing and non-sparking, coated aluminum impeller.
- B. Containment
1. The purpose of this section is to set a standard of performance for the bidder's laboratory fume hood before award of contract, and may not necessarily represent the operating conditions of the hoods after installation. Before or after award of contract, owners may require representative

- witness to said testing at their option, with failure to meet passing criteria as grounds for rejection of the bidder. Test data shall be provided at no cost to the owner.
2. Evaluation of manufacturer's standard product shall take place in manufacturer's test facility meeting the following criteria.
 - a. Lab to be located at manufacturer's place of business for the testing of bench-mounted laboratory hoods in accordance with ASHRAE Standard 110.
 - b. Room shall accommodate hoods up to 16' wide, while maintaining sufficient area so that a minimum of 15 feet of clear space is available in front of and 5' on both sides of hoods for viewing tests.
 - c. The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired ranges.
 - d. One hundred percent non-recirculated air to be both carbon and HEPA filtered to ensure removal of contaminants that could interfere with containment testing before entering the lab.
 - e. Make-up air to the test room shall be ceiling-supplied through any combination of multiple diffusers to either minimize adverse airflow, or increase it depending on test objectives.
 - f. Exhaust volumes shall be computer controlled and measured via AMCA calibrated orifices and flow station at each exhaust trunk.
 - g. Room pressurization must be digitally monitored, and variable depending on test objectives.
 - h. All equipment must be properly calibrated.
 - i. Qualified personnel familiar with the laboratory and its operation shall be available to perform the test.
 - j. Include the following instrumentation and test equipment:
 - 1) Properly calibrated hot wire thermal anemometer capable of measuring air velocities from 10 to 600 ft/minute; correlate with computer data acquisition format to provide simultaneous readings at all points.
 - 2) Theatrical smoke generator or other source of high volume smoke.
 - 3) Smoke tubes or other source of localized smoke.
 - 4) Leakmeter with traceable calibration, calibrated just before test, to indicated concentration of sulfur hexafluoride.
 - 5) Tracer gas: Sulfur hexafluoride supplied from a cylinder with two stage regulator.
 - 6) Adjustable mannequin, 5' 0" to 5'8" in height, with reasonable human proportions, clothed in a smock
 - 7) Inclined manometer with graduations no greater than 0.2 inch of water.
 - 8) Ejector system: Tracer gas ejector built to specific ASHRAE-110 requirements.
 - 9) Critical orifice: Sized to provide tracer gas at four or eight liters per minute at an upstream pressure sufficient to maintain release rate.
 - 10) Data acquisition software to include HoodPro™ and LabMeasurePro™ from Exposure Control Technologies, Inc.
 3. Hood shall be tested to ASHRAE 110 modified test method as detailed below.
 4. Some fume hoods may use face velocity controls, motorized baffles, integral auxiliary make up, or supply fans. Because all of these devices are subject to failure, containment testing shall show both operational containment and product containment with these systems off.
 5. Fume hood sashes shall be placed in their full open position, at least 28" from the work surface, unless noted otherwise.
 6. Ambient Temperature: 68 to 74 degrees F
 7. **Average Face Velocity:** Face velocity average shall be 60 fpm, as noted below in subsection 8.d, parts 1 and 2, plus or minus 5%.
 - a. An imaginary grid is formed comprised of equal 12" by 12" squares, or smaller, across the face opening of the laboratory hood. Airflow velocity readings are taken at the intersections

- of these grids with calibrated hot wire anemometer over a twenty second period of time. Probes shall communicate readings to a computer data acquisition package, which will provide an average of each reading over the one-minute period and also an overall average upon completion of data acquisition. Face velocity shall be determined by averaging readings at the hood face.
- b. Average face velocity must be achieved without exceeding the CFM noted in part C.
- 8. Tracer Gas Detection:** Hood shall achieve a rating of 4.0AM0.00 maximum average and 4.0AM0.01 maximum spike (unless specifically otherwise noted), wherein:
- a. 4.0 = tracer gas release in liters/minute, AM = as manufactured, 0.01 = tracer gas in parts per million (PPM)
 - b. With the ejector body 6" from the rear of the sash plane, the test shall be conducted for each ejector position noted.
 - 1) Left position with ejector 12" from the left interior wall.
 - 2) Center position with ejector equidistant from the sidewalls.
 - 3) Right position with ejector 12" from the right interior wall.
 - c. Install mannequin positioned in front of the hood, centered on the ejector.
 - d. Detector probes shall be placed 3" in front of the sash plane. The test shall be conducted for each detector probe position and corresponding face velocity.
 - 1) Detector probe in the region of the **nose and mouth of the mannequin**. Test with average face velocity of **60 fpm**.
 - 2) With the mannequin height reduced 4", place detector probe in the **chest of the mannequin**, and even with the height of the ejector. Test with average face velocity of **60 fpm**.
 - e. Open tracer gas valve, and collect readings with a computer data acquisition package, which is capable of monitoring and visually recording a minimum of one reading per second for a minimal five minute time period for each position.
 - f. The single control rating of the fume hood shall be the results of the test position yielding the highest average levels of tracer gas in any of the six mannequin/ejector configurations.
 - g. With the ejector and mannequin in the center position, detector probe in the region of the **nose and mouth of the mannequin**, average face velocity of **60 fpm**, tracer gas released, and concentration recorded, open and close the sash in a smooth motion. Test to be repeated three times, with peak values of 0.01 PPM or less.
 - h. With the mannequin removed, the periphery of the hood is traversed by the probe at 1" in front of the hood opening at a rate of 3 inches per second. The hood shall have a maximum perimeter reading of 0.03 PPM or less.
- 9. Flow Visualization:**
- a. Test the operation of the lower air bypass airflow opening and hood periphery by introducing light smoke under the air foil, and around the perimeter of the sash opening. If any smoke that enters the hood reverses directions and escapes from any of these locations, the hood fails this portion of the test and receives no rating.
 - b. Introduce smoke along both walls and the hood floor in a line parallel to the hood face and 6 inches (152 mm) back into the hood. Define air movement toward the face of the hood as reverse airflow and define lack of movement as dead air space. All smoke should be carried to the back of the hood and out.
 - c. Introduce a large volume of smoke at the work surface in the center of the hood, and 6" inside the plane of the sash. Define air movement toward the face of the hood as reverse airflow and define lack of movement as dead air space. All smoke should be carried to the back of the hood and out.
 - d. All data on the above, including instrumentation and equipment, and test conditions shall be provided on a report, including the average face velocities, and a separate graph-type

performance curve on all tracer gas tests for all required fume hood widths. Performance test data for a 6' representative hood shall be conducted by an independent testing agency and by a specific individual certified to perform such tests by the National Environmental Balancing Bureau (NEBB).

- C. Efficiencies
 - 1. The fume hood shall maintain constant volumetric rate (+/- 5 CFM) and static pressure losses (+/- 0.01" H2O) across all sash positions.
 - 2. The fume hood shall demonstrate a minimization of the volumetric rate of air (CFM) requirement at any given face velocity.
 - 3. The fume hood shall demonstrate a minimization of static pressure loss (inches of H2O) at any given CFM.
- D. Noise Criterion: The hood shall have a Noise Criterion (NC) rating of less than 50; measured 36" in front of the hood with full open sash, at 100 fpm face velocity. NC is a factor of sound pressure level (dB) and frequency.
- E. Illumination: Shall be a minimum average of 80 foot-candles inside the work area. Work area is defined as the area inside the lined portion of the fume hood, from the face of baffle to sash plane, from interior left to interior right, and from the work surface to a height of 28 inches.
- F. Materials of Construction: Interior and Exterior materials of construction and finishes shall meet the requirements in Part 2 of this specification.

1.5 QUALITY ASSURANCE

- A. Fume hoods shall be designed, including comprehensive engineering analysis, by a qualified, licensed Professional Engineer.
- B. Manufacturer's Qualifications
 - 1. ISO 9001 Certified manufacturing plant and processes.
 - 2. Ten installations of equal or larger size and requirements. Provide contact at each.
 - 3. Only hood manufacturers who have had fume hoods as a principal product for 30 years are considered.
- C. Fume hoods shall be Made in America
 - 1. 95% or more of raw material and component suppliers shall be United States based.
 - 2. Stainless and cold rolled steel used in manufacturing shall be sourced from United States steel mills.
 - 3. Final product must be fabricated and assembled within the United States of America.
 - 4. Owner reserves the right to evaluate Made in America claims for compliance with the Bureau of Consumer Protection.

- D. Supply all equipment in accordance with this specification. Offering a product differing in materials, construction, or performance from this specification requires written approval obtained seven days or more before the proposal deadline.
- E. The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.
- F. Manufacturer's warranty against defects in material or workmanship on its fume hoods will be for 1 year from date of installation or 2 years from date of purchase, whichever is sooner, and includes replacement of parts (except lamps) and labor.

1.6 SUBMITTALS

A. Action Submittals

- 1. Laboratory hood specification sheets and product manuals shall be submitted by the hood manufacturer upon request, and include safe and proper operation and maintenance information.
- 2. Shop Drawings: Include plans, elevations, sections, and details.
 - a. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports.
 - b. Indicate locations and types of service fittings together with associated service supply connection required.
 - c. Indicate duct connections, electrical connections, and locations of access panels.
 - d. Include roughing-in information for mechanical, plumbing, and electrical connections.
 - e. Provide face opening, volumetric rates, and static pressure drop data.
- 3. Submit a document detailing the information supplied on the Hood Safety Practices Label to verify compliance to specifications.

B. Informational Submittals

- 1. Product Test Reports: Showing compliance with specified performance requirements, including NEBB representative test report as defined previously.
- 2. Independent validation:
 - a. Written verification that the laboratory fume hoods carry the ETL listed mark for the following.
 - 1) UL 61010-1 (formerly 3101-1), Underwriters Laboratories Inc., Electrical Equipment for Laboratory Use
 - 2) CAN/CSA C22.2 No. 61010-1, Canadian Standards Association, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
 - 3) UL 1805, Underwriters Laboratories Inc., Standard for Laboratory Hoods and Cabinets
 - b. Written verification that 230 volt model fume hoods carry the CE conformity marking as required by the Council of European Communities.
 - c. Written verification from an outside testing agency confirming coating compliance to SEFA 8-2010, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests
- 3. Documentation of ISO 9001 Certified manufacturing plant and processes.
- 4. List of five installations (of equal or larger size and requirements) is available upon request. Provide contact at each.
- 5. Declaration of Made in America. Owner reserves the right to evaluate Made in America claims for compliance with the Bureau of Consumer Protection.

C. Material Submittals

- 1. Samples for Verification: of the hood exterior wall material, interior liner and baffle material, epoxy work surface material, and color selection chips are available from the hood manufacturer upon request.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.
- B. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install fume hoods until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Acceptable Manufacturer: Labconco Corporation, 8811 Prospect Avenue, Kansas City, Missouri 64132
- B. Basis-of-Design Product: Labconco Protector Premier; for use with integral blower

2.2 MATERIALS

- A. Hood Interior Liner and Baffle
 - 1. Liner material must comply with UL 1805, and be listed within NRTL test report as proof of compliance.
 - 2. General Material Properties
 - a. Nonflammable, corrosion and chemical-resistant
 - b. Fiberglass reinforced polyester resin
 - c. Minimum thickness is 3/16"
 - d. Smooth, white finish
 - 3. Method of Construction
 - a. Liner shall be one continuous molded component, and of monolithic construction, including the left and right side walls, rear, ceiling, and duct collar. Liners that are bonded together, do not include the duct collar within the continuous structure, or are of panelized construction are not acceptable.
 - 4. Flame and Smoke Characteristics
 - a. Flame retardant, self-extinguishing, with a flame spread rating of 25 or less in accordance with ASTM-E84
 - 5. Chemical Resistance
 - a. Splash and Spill Resistance:
 - 1) Suspend sample panel in a vertical plane
 - 2) Apply five drops of each reagent listed with an eyedropper
 - 3) Apply liquid reagents at top of panel and allow to flow down full panel height
 - b. Fume Resistance:
 - 1) Place 25 milliliters of reagent into 100 milliliters beakers and position panel over beaker tops in the proper sequence. Ensure beaker pouring lip permits air to enter the interior atmosphere.
 - 2) After 24 hours remove panel, flush with water, clean with detergent, rinse, wipe dry and evaluate
 - c. Evaluation ratings: Change in surface finish and function shall be described by the following ratings

- 1) E: Excellent for intended service with expected long and economic life.
 - 2) G: Some staining may result with prolonged usage. Satisfactory for limited service. Tests under actual conditions suggested.
 - 3) F: Surface deterioration may be experienced with prolonged usage. Test under actual conditions.
 - 4) NR: Not Recommended
- d. Required minimum results for each reagent (Reagent, Rating)

Acetic Acid	G
Acrylic Acid	G
Aluminum Sulfate	E
Ammonium Bicarbonate	E
Ammonium Chloride	E
Ammonium Hydroxide	G
Ammonium Persulfate	E
Ammonium Thiocyanate	E
Amyl Alcohol	E
Aniline Sulfate	E
Antimony Trichloride	E
Arsenious Acid	E
Barium Chloride	E
Benzaldehyde	F
Benzene Sulfonic Acid	E
Bleach - Hypochlorite	E
Butyl Acetate	E
Butyric Acid	E
Calcium Chloride	E
Calcium Hypochlorite	E
Caprylic Acid(n-Octanoic Acid)	E
Carbon Disulfide Vapor	F
Hydrofluoric Acid	G
Hydrogen	E
Hydrogen Fluoride, Wet	F
Hydrogen Sulfide	E
Kerosene	E
Lead Acetate	E
Linseed Oil	E
Magnesium Carbonate	E
Magnesium Sulfate	E
Mercaptan, Organic, H ₂ S, H ₂ O, Butanol	E
Mercurous Chloride	E
Alcohol	E
Methyl Ethyl Ketone	G

Acetone	G
Aluminum Fluoride	E
Ammonia	E
Ammonium Carbonate	G
Ammonium Fluoride	F
Ammonium Nitrate	E
Ammonium Sulfate	E
Amyl Acetate	E
Aniline	F
Antimony Pentachloride	E
Aqua Regia (HNO ₃ -HCl) Aromatic Hydrocarbon	E
Barium Carbonate	E
Barium Hydroxide	F
Benzene	G
Benzoic Acid	E
Bromine, liquid	F
Butyl Alcohol E	E
Calcium Chlorate	E
Calcium Hydroxide	E
Calcium Sulfate	E
Carbon Dioxide	E
Hydrocyanic Acid	E
Hydrofluorosilic Acid	F
Hydrogen Chloride, Anhydrous	E
Hydrogen Peroxide	E
Hypochlorous Acid	E
Lactic Acid	E
Lime Slurry	E
Lithium Chloride	E
Magnesium Chloride	E
Malic Acid	E
Mercuric Chloride	E
Mercury	E
Methyl Chloride	F
Methyl Isobutyl Ketone	E

Moisture	E
Napthalene	E
Nickel Nitrate	E
Nitric Acid	E
Nitrogen	E
Oleic Acid	E
Perchloric Acid	NR
Phosphate Salts	E
Phosphoric Acid	E
Phosphoric: Nitric Vapor	E
Phosphoric: HCl, Sat. with Cl ₂	E
Phosphorous Trichloride, HCl, Cl ₂ , H ₂ O Vapors	E
Phthalic Anhydride	E
Potassium Bicarbonate	E
Potassium Chloride	E
Potassium Ferrocyanide	E
Potassium Nitrate	E
Potassium Persulfate	E
Propylene Glycol	E
Pyridine	F
Sodium Acetate	G
Sodium Bicarbonate	E
Sodium Borate	E
Sodium Carbonate	E
Sodium Cyanide	F
Sodium Hydroxide	G
Sodium Nitrate	E
Sodium Sulfide	E
Sodium Tetraborate	E
Stannic Chloride	E
Stearic Acid	E
Sulfite Liquors	E
Sulfur Chloride	E
Sulfonated Aliphatics, HCl, H ₂ S, Butanol vapors	E
Sulfur Dioxide: SO ₃ wet vapor	F
Sulfuric Acid	G
Sulfuric + Chromic	G
Sulfuric-Nitric Acids	G
Sulfurous Acid	G
Tartaric Acid	E
Toluene	G

Naptha	E
Nickel Chloride	E
Nickel Sulfate	E
Nitrobenzene	G
Nitrous Acid	E
Oxalic Acid	E
Phenol	F
Phosphonitrilic Chloride, Cl ₂ , HCl, benzene, H ₂ O Vapors	E
Phosphoric Vapor & Condensate	E
Phosphoric: HCl, Saturated with phosphorous	E
Phosphorous Oxychloride, CHI, Cl ₂ , H ₂ O Vapors	E
Phosphorous Sesquisulfide	E
Picric Acid in Alcohol	E
Potassium Carbonate	E
Potassium Dichromate	E
Potassium Hydroxide	F
Potassium Permanganate	G
Potassium Sulfate	E
PVA Emulsion	E
Silver Nitrate	E
Benzoate	E
Sodium Bisulfate	E
Sodium Bromide	E
Sodium Chloride	E
Sodium Ferricyanide	E
Sodium Hypochlorite	E
Sodium Sulfate	E
Sodium Sulfite	E
Sodium Xylene Sulfonate	E
Stannous Chloride	E
Styrene	G
Sulfur, molten, vapors	E
Sulfur Dioxide	E
Sulfur Dioxide Saturated H ₂ O; trace HF, H ₂ SO ₄ , H ₂ S, F ₂	E
Sulfur Trioxide	E
Sulfuric Acid + Dichromate	G
Sulfuric Acid vapor	G
Sulfuric - HCl	G
Tannic Acid	E
Tetrapotassium Pyrophosphate	E
Toluene Diisocyanate	E

Trichloroacetic Acid	E
Trichloroethylene, HCl, Cl ₂ , H ₂ O vapors	G
Trisodium Phosphate	F
Water	E
Zinc Sulfate	E

Trichloroethylene	G
Trichlorophenol	F
Waste, Organic, H ₂ O, HCl, Cl ₂ , vapors	E
Zinc Chloride	E

B. Sheet Steel

1. Side panels and access panels 20-gauge (or heavier) sheet steel.
2. Hood corner posts are 16-gauge sheet steel.
3. Ceiling enclosure panels are 18 gauge sheet steel.
4. Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M.

C. Chemical Resistant Finish

1. General: Prepare, treat, and finish welded assemblies after welding. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling.
2. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Third party validation required.
3. Powder-coat process required. Paint processes that release Volatile Organic Compounds (VOC) are not acceptable
4. Color for Fume Hood Finish:
 - a. Glacier White

D. Safety Glass

1. Tempered
 - a. Clarity and temper test to be as specified in latest edition of Glass Tempering Association, *Engineering Standards Manual*, Section 8.1.
 - b. Surface and interior visible quality to be as specified per ASTM C 1036, *Standard Specification for Flat Glass*, Table 4, Quality level Q3.

2.3 CONSTRUCTION

A. Superstructure:

1. Self-supporting, rigid structural assembly, to support inner wall consisting of fume hood liner and outer wall of sheet metal exterior.
2. Fabricated from galvanized steel.
3. Space shall accommodate fume hood wiring and plumbing components for service fixtures.
4. Access to fixture valves concealed in wall provided by exterior removable access panels or through removable access panels on the front posts.

B. Exterior

1. Fabricate from steel sheet with component parts screwed together.
2. Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.
3. Interchangeable side panels shall lift off without the use of tools to allow access to plumbing lines, service fittings, electrical wiring, counterbalance sash weights, and light fixtures. Exposed fasteners or hardware, and Velcro type fasteners, are not acceptable.
4. Corner posts
 - a. Pre-punched and plugged to accommodate up to 4 service fixtures per side
 - b. All services are accessible from the front of the hood.

- c. Aerodynamic shape
 - d. Accommodate two electrical duplexes per side.
 - e. Right hand corner post includes electrical switches and pre-cut for Airflow monitor installation.
 - f. Un-used penetrations shall be plugged.
5. Top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
 6. Panel above header shall be removable without the use of tools to allow access to mechanical connection, electrical wiring, counterbalance sash weights, and light fixtures. Exposed fasteners or hardware, and “hook-and-loop” type fasteners, are not acceptable.

C. Dimensions

1. Overall exterior dimensions are as follows:
 - a. 4 foot nominal width: 48” w x 66” h x 31.7”d
 - b. 5 foot nominal width: 60” w x 66” h x 31.7”d
 - c. 6 foot nominal width: 72” w x 66” h x 31.7”d
2. Overall interior dimensions are as follows:
 - a. 4 foot nominal width: 38.1” w x 48” h x 23.3”d
 - b. 5 foot nominal width: 50.1” w x 48” h x 23.3”d
 - c. 6 foot nominal width: 62.1” w x 48” h x 23.3”d

D. Hood Liner

1. Adhere interior liner components to superstructure.
2. Stainless steel fasteners shall be used on the interior ceiling for structural integrity.
3. Fasteners exposed to chemical environment are not acceptable.
4. Punch fume hood lining side panels to receive four service fittings, for use with remote controls, per side. Provide removable plug buttons for holes not used for indicated fittings.

E. Hood Baffle

1. Baffle system shall be designed to capture a wide range of gaseous densities without adjustment or moving components.
2. Shall provide a continuous horizontal slot at the work surface, vertical openings running the interior height of the hood on the left and right sides, and an opening at the ceiling running left to right.
3. The baffle system shall be constructed with the same material as the fume hood liner.
4. The baffles shall be removable for cleaning.
5. Exposed components to be non-metallic. Metal components exposed to chemical environment are not acceptable.
6. Moving parts or adjustment of any kind is not acceptable.

F. Exhaust Connection

1. Hood shall have a continuous component of fume hood liner, fiberglass reinforced polyester resin exhaust collar to connect with blower inlet.
2. Outlet of blower shall have a PVC adaptor for a round duct connection. 4-foot hood shall have a 10.8” ID duct connection, 5-foot and 6-foot hoods shall have a 12.8” ID duct connection.
3. Integral blower shall be capable of overcoming a maximum external static pressure and equivalent resistance in feet of straight duct per the chart below:

Hood Width	Max external static pressure in inches H ₂ O	Duct Connection diameter	Equivalent Resistance in feet of straight duct
4-foot hoods	0.17 inches	10 inch	75 feet
5-foot hoods	0.12 inches	12 inch	75 feet

6-foot hoods	0.17 inches	12 inch	70 feet
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G. Integral Blower

1. Hood shall have an integral blower mounted directly to the top of the fume hood
2. Blower housing shall be special purpose rigid PVC sheet extrusion compound designated for reduced smoke emission properties
3. Impeller wheel shall be a forward curved centrifugal aluminum wheel with heresite coating
4. The wheel and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency
5. Blower motor shall be belt-driven with an adjustable sheave
6. Blower motor shall be 1/3 HP or 1/2 HP based upon the following chart:

1/3 HP	100400040, 100400042, 100400060, 100400061
1/2 HP	100400050, 100400051, 100400070*, 100400071*, 100500040, 100500042, 100500050, 100500051, 100500060, 100500061, 100500070*, 100500071*, 100600040, 100600042, 100600050, 100600051, 100600060, 100600061, 100600070*, 100600071*

*Explosion Proof model

H. Airfoil

1. Cold Rolled Steel with Chemical-Resistant Finish.
2. Airfoil shall have an aerodynamic radius to sweep the air into the hood with minimal turbulence. Airfoil directs airflow across work top to remove heavier-than-air gases.
3. Must have 5 rows of perforations to allow the air to bypass underneath and through the foil and sweep across the work surface to prevent any back flow of fumes escaping from the front of the hood opening. This airflow continues even if blocked by the presence of the operator.
4. Foil must extend back under the sash to prevent closure of the lower by-pass opening when the sash is in the fully closed position, directly on top of the airfoil.

I. Sash Assembly

1. Glass: Fully tempered safety glass with unobstructed, side-to-side view of fume hood interior and service fixture connections.
2. Dimensions: The full sash opening height is 28", the total unobstructed viewing height is 37.5" measured from the work surface.
3. Sash Tracks: Steel with Chemical Resistant Finish. Shall include bump stops for opening and closing.
4. Sash Handle: extruded aluminum with Chemical Resistant Finish. Sash handle includes a perforated air passage directly atop the handle to bleed air into the hood chamber and direct chemical fumes away from the user's breathing zone. The handle is ergonomic in design and is easy to grasp when operating
5. Sash guides: Corrosion resistant extruded poly-vinyl chloride.
6. Sash System
 - a. Vertical Sash (Cable and Pulley)
 - 1) Hoods have a single vertical sash counterbalanced by a single weight.
 - 2) Sash and weight to be connected via aircraft cable meeting MIL-W-83420 Military Specification.
 - 3) Rear pulleys shall be connected via timing shaft to prevent sash tilting and permit one finger operation at any point along full width sash handle. Maximum 7 pounds pull required to raise or lower sash throughout its full length of travel.
 - 4) Design system to hold sash at any position without creep and to prevent sash drop in the event of cable failure.

- 5) Include a defeatable, and automatically resetting sash stop positioned for an 18" sash height.

J. Electrical Components

1. Lighting
 - a. Provide UL Listed, high-efficiency, quick-start, T8 fluorescent lighting systems, including bulbs.
 - 1) 4 Foot Hoods - 2 each, 3-foot 25-watt fluorescent lamps
 - 2) 5 Foot Hoods - 2 each, 4-foot 32-watt fluorescent lamps
 - 3) 6 Foot Hoods - 2 each, 4-foot 32-watt fluorescent lamps
 - b. Vapor-Proof: all electrical components shall be outside of the contaminated air space. Lighting shall be located behind a laminated safety glass shield, sealed to the top of the hood liner.
 - c. The fluorescent light assemblies shall be serviceable from outside the fume hood cavity, without the use of tools.
 - d. Light switch to be included on the lower right corner post, at heights compliant with the Americans with Disabilities Act (ADA).
2. Blower Switch
 - a. Hoods shall be provided with blower switch, on the lower right corner post, at heights compliant with the Americans with Disabilities Act (ADA).
3. Electrical Receptacles
 - a. The hoods shall accommodate up to four (two per corner post) electrical receptacles as indicated in schedule or drawings. Options to include:
 - 1) 115 volt, 60 Hz, three-wire polarized and grounded electrical duplex, with Ground Fault Circuit Interruption (GFCI)
 - b. Receptacles shall be individually wired to field wiring box, and each rated at 20 Amperes.
 - c. Cover plates shall be acid resistant thermoplastic.
4. Wiring
 - a. Every electrical component shall be individually wired to a single point internal field wiring box (including individual duplexes/receptacles).
 - b. Field wiring box to be 7" x 4" x 2.5", grounded, and have (12) 7/8" diameter knock out penetrations.
 - c. Final wiring and circuit dedication is to be by others.
 - d. Each receptacle circuit shall accommodate being wired to a dedicated building circuit rated at 20A, or the receptacles ganged together on a building circuit with the total load not exceeding 20 Amperes.
5. Fume hood to have third party validation of compliance to UL 1805 and UL 61010-1 by a Nationally Recognized Testing Laboratory (NRTL)

K. By-Pass Opening

1. The size of the by-pass opening is controlled by sash position for use with a constant volume mechanical system. The hood shall not have a change in static pressure or exhaust volume across all sash positions.

L. Hood Safety Practices Label: Corrosion resistant plate attached to the corner post of the fume hood with the following Hood Safety Practices:

1. For use with substances that produce hazardous levels of airborne chemicals: gas, fumes, vapors, dust
2. Do not put your head in the hood.
3. Minimize drafts and sudden movements in front of the hood.
4. Work a minimum of six inches inside the hood.

5. Elevate equipment above the work surface.
6. Keep sill and baffle unobstructed.
7. Do not use the hood for storage.
8. Adjust the sash to smallest opening possible when in use.
9. Close sash when unattended.
10. Do not remove any of the hood components.
11. Do not place flammable solvents near heat, flame or sparks.
12. Do not evaporate large amounts of flammable liquids.
13. Wipe up spills immediately.
14. Routinely validate airflow.
15. If the ventilation system malfunctions, or airflow alarm indicates unsafe condition, close sash and discontinue hood operation immediately-call for help.
16. Do not use with Biohazards or Perchloric Acid

M. Fume Hood Accessories

1. Tissue Screen: Provide epoxy-coated, stainless-steel screen at bottom baffle opening to prevent paper from being drawn into the exhaust plenum behind baffles.
2. Rear Finish Panel: Shall be the same materials and coating as the hood exterior.
3. Ceiling Enclosure Panels:
 - a. Provide filler panels matching fume hood exterior to enclose space above fume hoods at front and sides of fume hoods and extending from tops of fume hoods to ceiling.
 - b. Exposed fasteners are not acceptable.
 - c. Height adjustment to be within the following ranges as specified in the schedule.
 - 1) 11.0 - 14.0"
 - 2) 14.0 – 18.6"
 - 3) 18.6 – 24.4"
4. Distillation Grid: Include stainless steel rods and connectors for field installation, and factory drilled liner.
5. Fire Suppression System: An ABC dry powder fire suppression system, with 165 degree Fahrenheit fusible link, shall be factory supplied and prepped, and field installed through the ceiling of the fume hood.
6. Face Velocity Monitor/Alarm
 - a. Audio/Visual Airflow Monitor
 - 1) Provide audible and visual alarm in the event of an unsafe face velocity.
 - 2) Alarm must sit flush with the fume hood corner post.
 - 3) Based on a thermally compensated thermistor in the alarm module, and air passing through a separate airstream into the hood interior.
 - 4) LED lights display red for alarm and green for normal operation.
 - 5) Must include external alarm and night setback functions.
 - 6) Alarm mute shall be accessible from the front of the monitor; visual alarm must remain activated until alarm condition is corrected.
 - 7) UL Listed electrical components
 - 8) Calibration shall be through a front located potentiometer.
 - 9) Calibration is the responsibility of the owner, following a complete balancing of the mechanical system, and concurrently with As-Installed testing.

N. Work Surface

1. 1.25" thick, molded from solid modified epoxy resin, with smooth, non-specular, black finish.
2. One inch radius front edge for optimal fume hood performance.
3. 3/8" dished area to match the fume hood interior work space and form a water tight pan for spill containment.

4. Include a 2.5" diameter hole on each side for service pass-through and piping. Hole to be covered by hood superstructure upon installation.
5. Include two 1.5" diameter penetrations to accommodate base cabinet venting. Holes to be located outside of dished area and under the fume hood baffles. Include plugs.
6. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa).
 - b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F (127 deg C).
 - f. Flame-Spread Index: 25 or less per ASTM E 84.

O. Supporting Base Cabinets

1. Base cabinets shall be in depths of 22", widths, quantities, and types called out in the equipment schedule, and meet the requirements of this specification.
2. Construction requirements for all cabinets
 - a. Exterior construction is 18 gauge (or heavier) cold rolled sheet steel with Chemical Resistant Finish.
 - b. Hinges are 10 gauge (or heavier) plate with self-clinching pilot pin. Knuckle, bullet, or piano type hinges are not accepted.
 - c. The rear panel will feature a 12" x 8" removable plumbing access panel.
 - d. Units 24" wide or less have only one door.
 - e. Each cabinet includes four leveling feet.
 - f. Capable of supporting up to 800 pounds.
 - g. An 8" filler panel is required to increase the cabinet depth to 30".
3. Standard Storage
 - a. Overall exterior dimensions:
 - 1) 48" 48" w x 22" d x 35.5"-36.75"
 - 2) 36" 36" w x 22" d x 35.5"-36.75"
 - 3) 30" 30" w x 22" d x 35.5"-36.75"
 - 4) 24" 24" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - 5) 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - 6) 12" 12" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - b. Flush pull handles are ABS, low gloss black.
4. Acid Storage
 - a. Overall exterior dimensions:
 - 1) 48" 48" w x 22" d x 35.5"-36.75"
 - 2) 36" 36" w x 22" d x 35.5"-36.75"
 - 3) 30" 30" w x 22" d x 35.5"-36.75"
 - 4) 24" 24" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - 5) 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - b. Completely lined with a polyethylene corrosion resistant liner. The liner is 3/16" thick, with a vacuum formed PVC liner pan at the bottom to contain spills. Each door has a 3/16" sheet polyethylene liner.
 - c. The cabinet is labeled: "ACID".
 - d. Flush pull handles are ABS, low gloss black.
 - e. Each cabinet is vented into the fume hood with a 1-1/2" vent pipe. It should provide a positive airflow directly into the fume hood exhaust system.
 - f. Supply an epoxy coated steel shelf with PVC liner pan if indicated in the schedule.
 - g. Acid cabinets with louvers are not acceptable

5. Solvent Storage
 - a. Overall exterior dimensions:
 - 1) 48" 48" w x 22" d x 35.5"-36.75"
 - 2) 36" 36" w x 22" d x 35.5"-36.75"
 - 3) 30" 30" w x 22" d x 35.5"-36.75"
 - 4) 24" 24" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - b. Solvent storage cabinets are specifically designed for the storage of flammable and combustible liquids.
 - c. Solvent Storage Cabinet must be compliant with NFPA 30 "Flammability and Combustible Liquids Code."
 - d. Cabinets 30" wide and greater shall be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050.
 - e. The bottoms, top, sides, and doors are fabricated of 18 gauge steel and are all double panel construction with a 1-1/2" air space between panels.
 - f. All joints are welded or screwed to provide a rigid enclosure. A 2" deep liquid tight pan that covers the entire bottom of the cabinet is furnished to contain liquid leaks and spills.
 - g. A full-depth, 18 gauge steel, adjustable shelf is also provided. Shelves are sealed leak tight.
 - h. Two diametrically opposed flame arrestor vents with spark screens are provided in the back of the cabinet, as well as a grounding screw.
 - i. The cabinet has an interior finish same as the exterior.
 - j. The cabinet is labeled: "FLAMMABLE - KEEP FIRE AWAY".
 - k. The right hand door shall have a three point latching device.
 - l. Door handles include a key lock. Solvent storage handles are locking lever handles with bright chrome finish.
 - m. If noted on the schedule, self-closing/self-latching models shall be provided with a fusible-link feature to ensure the doors will close if the temperature outside the cabinet exceeds 165 degrees Fahrenheit. The doors are synchronized so that both doors will fully close.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- B. Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in and for rough opening dimensions required for the installation of the hood.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fume hoods according to shop drawings and manufacturer's written instructions.
- B. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework.
- C. Securely attach access panels, but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- D. Neighboring splash blocks shall not be attached directly to the hood.
- E. Install according to standards required by authority having jurisdiction.
- F. Sequence installations to ensure utility connections are achieved in an orderly and expeditious manner.
- G. Touch up minor damaged surfaces caused by installation. Replace damaged components as directed by Architect.

3.3 FIELD QUALITY CONTROL

- A. NFPA 45 requires that fume hoods be field tested when installed.
- B. Field test installed fume hoods according to ASHRAE 110 to verify compliance with performance requirements.
 - 1. Adjust fume hoods, hood exhaust fans, building's HVAC system, and make other corrections until tested hoods perform as specified in fume hood schedule.
 - 2. After making corrections, retest fume hoods that failed to perform as specified.

3.4 ADJUSTING AND CLEANING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.
- B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Clean adjacent construction and surfaces that may have been soiled in the course of installation of work in this section.
- D. Provide all necessary protective measures to prevent exposure of equipment and surfaces from exposure to other construction activity.
- E. Advise contractor of procedures and precautions for protection of material and installed equipment and casework from damage by work of other trades.

SECTION 12 24 13 - ROLLER WINDOW 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manual light blocking shades Room E113.
- B. Related Sections include the following:
 - 1. Section 05 50 00 "Formed-Metal Fabrications" for custom sheet-metal pockets for window treatments.
 - 2. Section 06 10 00 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: 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 operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Draper Inc.
 - 2. Hunter Douglas Contract.
 - 3. Lutron Electronics Co., Inc.
 - 4. MechoShade Systems, Inc.
 - 5. Nysan Solar Control Inc.; a Hunter Douglas company.

- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
1. Bead Chains: Manufacturer's standard.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
1. Shadeband Materials: Light-blocking fabrics.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material and exposed with endcaps and integral light seal where bottom (sill) channels are indicated.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
1. Exposed Headbox for Opaque Fabric: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches (102 mm) or as otherwise indicated on Drawings.
 2. Endcap Covers: To cover exposed endcaps for installation outside of jambs.
 3. Side Channels for Opaque Fabric: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIAL

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 1. Source: Roller-shade manufacturer.
 2. Type: PVC-free polyester with opaque acrylic backing.
 3. Orientation on Shadeband: Up the bolt.
 4. Color: As selected by Architect from manufacturer's full range.

2.4 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
 2. Outside of Jamb Installation: 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.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Light-Blocking Shadebands: Located so shadeband is not closer than 2 inches (51 mm) to interior face of glass. Allow clearances for window operation hardware.

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.

END OF SECTION 12 24 13

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SECTION 12 35 59 - WOOD LABORATORY 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.

1.2 SUMMARY

A. Section Includes:

1. Wood laboratory casework.
2. Filler and closure panels.
3. Laboratory countertops, benchtops, and work surfaces.
4. Tables.
5. Shelves.
6. Laboratory sinks.
7. Safety shower.
8. Laboratory accessories.
9. Water service fittings.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood blocking for anchoring laboratory casework.
2. Section 09 65 13 "Resilient Base and Accessories" for resilient base applied to wood laboratory casework.
3. Refer to Facility Services Subgroup for Safety Showers, Laboratory Fume Hoods, and glassware washer.

1.3 DEFINITIONS

- A. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1200 mm) above floor, and visible surfaces in open cabinets or behind glass doors.

1. Ends of cabinets, including those installed directly against walls or other cabinets, are defined as "exposed."
2. Ends of cabinets indicated to be installed directly against and completely concealed by walls or other cabinets are defined as "concealed."

- B. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cases 78 inches (1980 mm) or more above floor and bottoms of cabinets more than 24 inches (600 mm) but less than 48 inches (1200 mm) above floor are defined as semiexposed.

- C. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.
- D. MDF: Medium-density fiberboard.
- 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.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.

1.5 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.
- B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, and attachment details.
 - 1. Indicate types and sizes of cabinets.
 - 2. Indicate locations of hardware and keying of locks.
 - 3. Indicate locations and types of service fittings.
 - 4. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 - 5. Include details of utility spaces showing supports for conduits and piping.
 - 6. Include details of exposed conduits, if required, for service fittings.
 - 7. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
 - 8. Include coordinated dimensions for laboratory equipment specified in other Sections.
- C. Product Schedule:
 - 1. Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.
- D. Samples for Initial Selection: For cabinet finishes and other materials requiring color selection.

- E. Samples for Verification: For each type of cabinet finish and each type of countertop material, in manufacturer's standard sizes.
- F. Samples for Verification: Unless otherwise directed, approved full-size Samples may become part of the completed Work, if in an undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations. If acceptable full-size Samples at Project site are not incorporated into the Work, retain and remove them when directed by Architect.
 - 1. One full-size, finished base cabinet complete with hardware, doors, and drawers.
 - 2. One full-size, finished wall cabinet complete with hardware, doors, and adjustable shelves.
 - 3. One Sample each of hinged and sliding doors.
 - 4. 6-inch- (150-mm-) square Samples for each type of countertop material.
 - 5. One of each service fitting specified, complete with accessories and specified finish.
 - 6. One of each type of sink and accessory item specified.
 - 7. One of each type of hardware item specified.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Test Reports:
 - 1. Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard.
 - 2. Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cabinet Mounting Clips and Related Hardware: Quantity equal to 5 percent of amount installed, but no fewer than 20 of each type.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 W.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS**2.1 CASEWORK MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CIF Laboratory Solutions.
 - 2. Kewaunee Scientific Corporation.
- B. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
 - 1. Obtain countertops, sinks, and accessories from casework manufacturer.
- C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with Specifications may be considered. See Section 01 60 00 "Product Requirements."

2.2 CASEWORK, GENERAL

- A. Casework Product Standard: Comply with SEFA 8 W, "Laboratory Grade Wood Casework."
- B. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.3 WOOD CASEWORK

- A. Design: Full overlay with square edges.

1. Provide 1/8-inch (3.2-mm) reveals between doors and drawers that are adjacent.
- B. Wood Species: Red oak.
- C. Cut: Plain sliced/sawn.
- D. Matching:
 1. None required; select and arrange components for compatible grain and color.
 2. Provide veneers for each cabinet from a single flitch, book and balance matched.
 - a. Provide continuous matching of adjacent drawer fronts within each cabinet.
- E. Grain Direction:
 1. Vertical on doors, horizontal on drawer fronts.
 2. Vertical on end panels.
 3. Vertical on knee-space panels.
 4. Horizontal on aprons and table frames.
- F. Exposed Materials:
 1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
 2. Plywood: Hardwood plywood, either veneer core or particleboard core with face veneer of species indicated. Grade A exposed faces, at least 1/50 inch (0.5 mm) thick, and Grade J crossbands. Provide backs of same species as faces.
- G. Semiexposed Materials:
 1. Plywood: Hardwood plywood of any species similar in color and grain to exposed plywood. Grade B faces and Grade J crossbands. Provide backs of same species as faces.
- H. Concealed Materials:
 1. Solid Wood: Any species, with no defects affecting strength or utility.
 2. Plywood: Hardwood plywood. Provide backs of same species as faces.
 3. Particleboard.
 4. MDF.
 5. Hardboard.

2.4 WOOD CABINET AND TABLE MATERIALS

- A. General:
 1. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- B. Composite Wood Products: Products shall be made without urea formaldehyde.
- C. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

- D. MDF: ANSI A208.2, Grade 130.
- E. Particleboard: ANSI A208.1, Grade M-2.
- F. Hardboard: ANSI A135.4, Class 1 Tempered.
- G. Adhesives: Do not use adhesives that contain urea formaldehyde.
- H. Edgbanding for Wood-Veneered Construction: Rigid PVC extrusions, through color with satin finish, 3 mm thick at doors and drawer fronts, 1 mm thick elsewhere.
 - 1. Colors: As selected by Architect from manufacturer's full range.

2.5 AUXILIARY CABINET MATERIALS

- A. Acid Storage-Cabinet Lining: 1/4-inch- (6-mm-) thick, polyethylene, polypropylene, epoxy, or phenolic-composite lining material.
- B. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.6 COUNTERTOP TABLETOP, SHELF, AND SINK MATERIALS

- A. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durcon Laboratory Tops, Inc., 206 Allison Drive, Taylor, TX 76574; Telephone: (512) 595-8000.
 - b. Epoxyn Products, 500 East 16th Street, Mountain Home, AR 72653; Telephone: (870) 425-4321.
 - c. Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687; Telephone: (704) 873-7202.
 - d. Prime Industries, Inc., 2600 Warrenville Road, Suite 205, Downers Grove, IL 60515; Telephone: (630) 725-9200.
 - 2. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa).
 - b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F (127 deg C).
 - 3. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol,

ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.

b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

4. Color: Black.

B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

2.7 FABRICATION

A. Construction: Provide wood-faced laboratory casework complying with SEFA 8 W and of the following minimum construction:

1. Bottoms of Base Cabinets and Tall Cabinets: 3/4-inch- (19-mm-) thick, veneer-core hardwood plywood.
2. Tops and Bottoms of Wall Cabinets and Tops of Tall Cabinets: 1-inch- (25-mm-) thick, veneer-core hardwood plywood.
3. Ends of Cabinets: 3/4-inch- (19-mm-) thick, hardwood plywood.
4. Shelves: 1-inch- (25-mm-) thick, veneer-core hardwood plywood.
5. Base Cabinet Top Frames: 3/4-by-2-inch (19-by-50-mm) solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
6. Exposed Backs of Cabinets: 3/4-inch- (19-mm-) thick, hardwood plywood.
7. Unexposed Backs of Cabinets: 1/2-inch- (12.7-mm-) thick, hardwood plywood dadoed into sides, bottoms, and tops, unless otherwise indicated.
8. Drawer Fronts: 3/4-inch- (19-mm-) thick, hardwood plywood or solid hardwood.
9. Drawer Sides and Backs: 1/2-inch- (12.7-mm-) thick, solid hardwood or veneer-core hardwood plywood, with glued dovetail or multiple-dowel joints.
10. Drawer Bottoms: 1/4-inch- (6.4-mm-) thick, veneer-core hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- (12.7-mm-) thick material for drawers more than 24 inches (600 mm) wide.
11. Doors 48 Inches (1200 mm) High or Less: 3/4 inch (19 mm) thick, with particleboard or MDF cores, solid-hardwood stiles and rails, and hardwood face veneers and crossbands.
12. Stiles and Rails of Glazed Doors 48 Inches (1200 mm) High or Less: 3/4-inch- (19-mm-) thick, solid hardwood.

B. Tables: Solid-hardwood legs, not less than 2 inches (50 mm) square with solid-hardwood stretchers as needed to comply with product standard. Bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device at bottom of each leg.

1. Leg Shoes: Black vinyl or rubber, open-bottom, slip-on type.

C. Removable Backs: Provide backs that can be removed from within cabinets at utility spaces.

D. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.

1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed.

2. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
3. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.8 WOOD FINISH

- A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand 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. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard three-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 W. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

2.9 HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Butt Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches (1200 mm) high or less and three for doors more than 48 inches (1200 mm) high.
- C. Hinged Door and Drawer Pulls: Stainless-steel or chrome-plated-brass back-mounted pulls. Provide two pulls for drawers more than 24 inches (600 mm) wide.
 1. Design: Rectangular loop pulls with rounded corners.
 2. Overall Size: 1-3/8 by 5-1/2 inches (35 by 140 mm).
- D. Door Catches: Nylon-roller spring catches. Provide two catches on doors more than 48 inches (1200 mm) high.
- E. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
 1. Provide Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
 2. Provide Grade 1HD-200; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
 3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-overtravel-extension, ball-bearing type.

- F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches (25 by 50 mm), attached with screws or rivets. Provide on all drawers.
- G. Locks: Cam type with five-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281 or Type E07261.
 - 1. Provide a minimum of two keys per lock and four master keys.
 - 2. Provide on all drawers and doors.
 - 3. Keying: Key locks as directed.
 - 4. Master Key System: Key all locks to be operable by master key.
- H. Adjustable Shelf Supports: Mortise-type, powder-coated steel standards and shelf rests complying with BHMA A156.9, Type B04071 and Type B04091.
- I. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Type B04102 and Type B04112.

2.10 COUNTERTOPS, TABLETOPS, SHELVES AND SINKS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch (25 mm), with continuous drip groove on underside 1/2 inch (13 mm) from edge.
- B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - 1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwise indicated.
 - 2. Overflows: Where indicated, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.
- C. Epoxy Countertops, Tabletops, and Sinks:
 - 1. Countertop Configuration: Flat, 1 inch (25 mm) thick, with beveled or rounded edge and corners, and with drip groove and integral coved or applied backsplash.
 - a. Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.
 - 2. Tabletop Fabrication: Flat, 1 inch (25 mm) thick, with beveled or rounded edge and corners, and with drip groove at perimeter.
 - 3. Sink Fabrication: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.
 - a. Provide with polypropylene strainers and tailpieces.
 - b. Provide manufacturer's recommended adjustable support system for table- and cabinet-type installations.

- D. Cup Sinks: Material and size as indicated.
 - 1. Provide epoxy cup sinks with polypropylene strainers and integral tailpieces.

2.11 LABORATORY ACCESSORIES

- A. Clear Acrylic Drying Rack:
 - 1. Drying rack bodies shall be of 3/4 inch (18 mm) thick clear acrylic with eased corners and edges. Bottom edge shall be cut to form 45-degree drip edge with 1/8 inch (3mm) flat edge at bottom to prevent damage. Each rack shall be of the size and with the peg arrangement shown on the Laboratory Furnishing drawings. Edges shall be polished.
 - 2. Pegs shall be of injection molded white polypropylene. Pegs shall not be bonded into the body, but shall be held in position by mechanical design.
 - 3. Provide 1/2 inch (13 mm) diameter x 1/2 inch (13 mm) thick clear acrylic rod spacers and stainless steel fixing screws of appropriate type for attachment to support structure.
 - 4. Engineer rack and supports to accommodate installation of owner-furnished owner-installed water purification unit on the portion of the rack without pegs. Allow for up to 50 pounds of load capacity.
- B. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop unless otherwise indicated.
- C. Upright Rod Assembly and Metal Crossbar: Aluminum or stainless steel. Two vertical rods and one horizontal crossbar, 3/4 inch (19 mm) in diameter and 36 inches (900 mm) long unless otherwise indicated; two flush socket receptacles and two crossbar clamps. Ends of vertical rods are tapered to fit receptacles; all other rod ends are rounded.

2.12 WATER SERVICE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Broen A/S.
 - 2. Chicago Faucets; Geberit Company.
 - 3. WaterSaver Faucet Co.
- B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.
 - 1. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.
- C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.
 - 1. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.

- D. Finish: Chromium plated.
- E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig (550 kPa).
 - 1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
 - 2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
 - 3. Self-Closing Valves: Provide self-closing valves where indicated.
- F. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than 5 lbf (22 N) to operate. Provide units designed for working pressure up to 75 psig (520 kPa), with serrated outlets.
- G. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."
- H. Handles: Provide wrist paddles handles for valves unless otherwise indicated.
 - 1. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
- I. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
 - 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet (1.5 mm in 3 m).
 - 2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet (3 mm in 3 m).
 - 3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet (3 mm in 3 m).
 - 4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).
 - 5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.5 mm).

- B. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than 16 inches (400 mm) o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
 - 1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o.c. and at sides of cabinets with not less than two fasteners per side.
- C. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches (400 mm) o.c.
- D. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- E. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where indicated on Shop Drawings.
- B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.
 - 1. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.
- C. Fastening:
 - 1. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches (1200 mm) o.c.
 - 2. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch (3 mm,) and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- D. Provide required holes and cutouts for service fittings.
- E. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- F. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

- A. Comply with installation requirements in SEFA 2.3.
- B. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
- C. Drop-in Installation of Epoxy Cup Sinks: Rout groove in countertop to receive sink rim if not shop prepared. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

- A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.
- D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in other Sections for installing water service fittings and electrical devices.
- B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil (0.15-mm) plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches (1200 mm) o.c.

END OF SECTION 12 35 59

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SECTION 22 00 00 - PLUMBING**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. This Section of the Specification includes the furnishing and installation of complete drainage, water supply, plumbing fixtures and other equipment as described herein and as indicated on the Drawings.

1.2 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment, clearly indicating exactly what features, options and accessories are being provided.
- B. See Section 23 01 00.

1.3 SEWER AND WATER CONNECTIONS:

- A. Connections to on site water, sewer and gas services shall be in accordance with the requirements of the 2012 International Plumbing Code and the respective Utility Company. Pay all associated tap and meter fees and costs.
- B. Before any new sewer work is done, the Contractor shall uncover the sewer line where connection is to be made and shall determine the actual elevation. If the actual elevation of the sewer at the point of connection is such that the new drainage line cannot be installed with the required slope to the new fixtures, the matter shall be referred to the Architect as soon as possible.

PART 2 - PRODUCTS**2.1 DRAINAGE AND VENT PIPING:**

- A. Hub-and-Spigot Pipe: Hub-and-spigot cast-iron pipe not larger than 15-inch size shall be service weight ASTM A74, coated. All changes in pipe size of soil, waste, and drain lines shall be made with reduction fittings or reducers. Changes in direction, where space permits, shall be made with long sweep bends, Y-fittings and 1/8 or 1/16-bends, or combination Y and 1/8-bends. Sanitary tee branches and 1/4-bends may be used for connections of branch lines to fixtures and on vertical runs of pipe. Hub-and-spigot cast-iron pipe larger than 15-inch size shall be Type II or III; Grade C, cast-iron pressure pipe.
 - 1. Gasketed Joints: Molded neoprene elastic compression type gaskets. Gaskets shall conform to ASTM C 564, and pipe, fittings, and gaskets shall bear the symbol of the Cast Iron Soil Pipe Institute. Pipe and fittings shall be manufactured with the spigot ends plain and beveled, and the bells shall be modified to receive the gaskets. Service weight soil

pipe and fittings shall be joined with service weight gaskets. Service weight gaskets shall be clearly designated and identified. A lubricant shall be used in making the joints. When the joint is completed, a tight seal shall be formed between the external face of the pipe and the internal face of the bell. Gaskets shall be capable of making and maintaining a tight seal with a deflection not to exceed 5 degrees. Deflection of pipe will not be allowed to avoid the use of a fitting. Joints shall be assembled by the tools and as recommended by the pipe, fittings, and gasket manufacturers.

- B. "No-Hub" Cast-Iron Pipe: "No-Hub" cast-iron soil pipe and fittings shall conform to Cast Iron Soil Pipe Institute Specification 301 and ASTM A-888. Pipe, fittings, and couplings shall bear the symbol of the Cast Iron Soil Pipe Institute. "No-Hub" piping systems shall be installed in accordance with the manufacturer's recommendations.
- C. Threaded Steel Pipe: Threaded steel pipe shall be galvanized, Schedule 40 conforming to ASTM A 53.
- D. Threaded Copper Nickel Steel Pipe: Threaded copper nickel steel pipe shall conform to ASTM A 714, Grade V, galvanized.
- E. Threaded Cast Iron Pipe: Threaded cast iron pipe shall comply with ASTM A-74.
1. Fittings on threaded ferrous soil, waste, and drain piping, including storm drainage piping and couplings on pipes 6- inches and smaller, shall comply with ANSI B 16.12. Short tee branches and short turn elbows may, except for wall hung water closets, be used for connections of branch lines to fixture and on vertical runs of pipe; long turn fittings shall be used in all other locations where space permits. Fittings may be galvanized or black, coated or uncoated. Couplings on pipes 8-inches and larger shall be standard weight steel, zinc-coated (galvanized) and need not be recessed; steel couplings shall not be used on piping 6- inches and smaller.
 2. Fittings on threaded ferrous vent pipes shall comply with ANSI B 16.3, B16.4, or B 16.12. Couplings shall be as specified above for soil, waste, and drain piping.
- F. Copper Tubing: Copper tubings shall be Type M, in accordance with ASTM B-88, or Type DWV in accordance with ASTM B 306. Ends of tubing shall be cut square and shall be reamed before being made up. Tubing ends shall enter the full depth of the fitting recesses without binding.
1. Fittings for copper tubing shall be solder type, recessed drainage pattern, of wrought copper or cast brass. Recesses shall be smooth and correctly sized to provide proper clearance over the tubing. Solder shall be composition 95/5 tin-antimony or Brigit. Flux shall be noncorrosive. Tubing ends and fitting recesses shall be thoroughly cleaned. Solder shall penetrate fully and shall fill the joint completely.
- G. Plastic Pipe and Fittings:
1. Schedule 40 PVC, ASTM D-1784 with solvent welded joints.
 2. Schedule 40 chlorinated polyvinyl chloride (CPVC) Type IV Grade I compounds with a minimum cell classification of 23447. Pipe and Fittings shall conform to ASTM F 2618. One-Step solvent cement shall be specially formulated for chemical waste applications and conform to ASTM F493. All pipe, fittings and cement shall be supplied as a system by a single manufacturer and shall be certified by NSF International for use in corrosive waste drainage systems and shall bear the mark "NSF-cw". Flame spread rating not over 25 and a smoke developed rating not higher than 50 per ULC S102.2.

- a. Acceptable Manufacturers: Charlotte Pipe “ChemDrain”, Spears.

H. Acid Resistant Piping and Fittings shall be:

- 1. Schedule 40 polyvinylidene (PVDF), ASTM F1673, ASTM D3222 and meeting ASTM E84 25/50 for flame spread and smoke development and UL-723 requirements for flame propagation and smoke density in environmental spaces. Pipe shall be factory and/or field grooved for mechanical joint systems; or field heat-fused using the manufacturer-recommended joining system. Fittings shall meet or exceed schedule 40 dimensions. The joint system shall have a corrosion resistance equal to the pipe and fittings.
 - a. Acceptable Manufacturers: GSR Sloan, Labline Enfield, Orion, Zurn.

2.2 UNDERGROUND WATER PIPING:

- A. Underground domestic water piping beyond five feet outside the building shall be as specified by the Civil Engineer.

- B. Underground water piping beneath the building to a point five feet outside the building shall be:

- 1. Cross-linked polyethylene (PEX).
 - a. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency.
 - 1) Standard grade hydrostatic design and pressure ratings from Plastic Pipe Institute.
 - 2) Minimum Bend Radius (cold bending): No less than 6 times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
 - 3) Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876.
 - b. Fittings:
 - 1) Joints below grade shall be avoided if possible.
 - 2) Fittings shall be of a type approved by the piping manufacturer for the application, and shall be supplied by piping manufacturer.
 - 3) Material: Fittings shall be suitable for direct burial in earth, and shall be manufactured from one of the following –
 - 4) Same material as piping.
 - 5) Pollyalloy (ASTM 2359).
 - 6) Bronze (w/ stainless steel sleeve) (ASTM 877).
 - 7) Dezincified brass (ASTM 1807).
 - 8) Material Standard: Comply with ASTM F1960.
 - c. Accessories
 - 1) Bend supports designed for maintaining tight radius bends shall be supplied by the PEX tubing manufacturer.
 - 2) Tools required to install the piping fittings shall be supplied by the PEX tubing manufacturer.

- 3) The tubing manufacturer will provide clips and/or PEX rails for supporting tubing runs.
- d. Warranty:
 - 1) Warranty Period for PEX piping and fitting system shall be 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
- e. Acceptable Manufacturers – Mr. Pex, Uponor, Viega.

2.3 ABOVEGROUND WATER PIPING:

- A. Aboveground domestic water piping 3-inches in size and smaller, shall be copper tubing, Type L, hard drawn, ASTM B-88. Fittings shall be one of the following:
 1. Recessed solder- joint type of either wrought copper or cast brass. Adapters for connection to threaded valves, fittings, meters and other equipment shall be cast brass. Recesses shall be smooth and correctly sized to provide proper clearance over the tubing. Solder shall be composition 95/5 tin-antimony or Brigit. Flux shall be noncorrosive. The solder shall contain no lead.
 2. Mechanical grooved joint pipe couplings may be used for connecting equipment to the piping system, headers, and distribution piping in lieu of soldered tube or fitting connections for water piping with NSF-61 rated temperatures to +180°F. System shall meet the low lead requirements of NSF-372.
 - a. Coupling housing clamps shall consist of two ductile iron castings complying with ASTM A-536, cast with offsetting angle-pattern bolt pads. Housing clamps shall hold in place an elastomer water sealing gasket of a FlushSeal® pressure responsive design. Clamps and gaskets shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)
 - 1) Victaulic Style 607H ‘Quick-Vic’ installation ready coupling, for direct stab installation without field disassembly.
 - b. Fittings shall be manufactured to copper-tube dimensions, ASME B16.22 or ASME B16.18 Victaulic Copper-Connection.
 - c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. For use with copper-tube dimensioned grooved ends. Victaulic Style 641.
 3. Victaulic Installation-Ready™ fittings for grooved end copper tubing shall be manufactured to copper-tube dimensions. Fittings shall be ductile iron conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, complete with PVDF (Poly Vinylidene Fluoride) and Grade “EHP” EPDM-HP [Grade ‘T’ Nitrile] gasket; and ASTM A449 electroplated steel bolts and nuts. System shall be rated to 300 psi (2065 kPa) with Type K or L Copper Tubing.
 4. Viega ProPress Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have SC

(Smart Connect) feature design (leakage path). Smart Connect™ (SC Feature) In ProPress ½" to 4" dimensions the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection (when testing from ½ to 85 psi). The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

- B. At contractor's option, and where noted on drawings, branch piping serving toilet rooms and downstream of toilet room isolation valves, and piping serving individual fixtures shall be PEX piping as specified for underground water piping.

2.4 UNDERGROUND SOIL, WASTE, VENT AND DRAIN PIPING:

- A. Underground soil, waste, vent and storm drainage piping shall be as follows (unless otherwise indicated on Drawings):
 1. Underground sanitary and storm drain lines shall be hub- and-spigot cast-iron, or plastic pipe.

2.5 ABOVEGROUND SOIL, WASTE, VENT AND DRAIN PIPING (includes condensate drain piping):

- A. Aboveground soil, waste, vent and storm drainage piping:
 1. Where exposed in rooms or where located in return air plenums, piping may be hub- and-spigot cast iron, or "No-Hub" cast iron, threaded galvanized steel, threaded copper nickel steel, threaded cast iron, copper tubing, or CPVC pipe. **PVC piping shall not be used where exposed or located in return air plenums.**
 2. Where installed inside walls or above ceilings that are not return air plenums, piping may be hub- and-spigot cast iron, or "No-Hub" cast iron, threaded galvanized steel, threaded copper nickel steel, threaded cast iron, copper tubing, PVC or CPVC pipe.
 3. Exposed waste piping and fittings in toilet rooms, and in finished areas, shall be chromium plated brass. Pipe shall be red brass, standard weight, iron pipe size and thickness, ASTM B-43, and fittings shall be threaded cast-brass of the recessed drainage pattern. Chromium plated piping shall be carefully measured and cut so that no more than one full turn of thread shall be exposed beyond any fittings. Joints between brass and ferrous pipes shall be threaded.
 4. Aboveground acid waste and vent piping shall be schedule 40 polyvinylidene (PVDF).

2.6 TRAPS:

- A. Provide deep seal traps on all floor drains.

2.7 CLEANOUTS AND FERRULES:

- A. Cleanouts shall be installed as shown on Drawings and where required by the building code.
- B. Cleanout plugs for threaded fittings shall be in accordance with Table 52 of CS 188. Except for test openings, where size must be sufficient to admit test plug, bushings will be permitted on

pipes 5-inches and larger to reduce plug size to 4-inches; cleanout plugs for piping 4-inches and smaller shall be the same size as the pipe.

- C. Cleanout plugs for hub-and-spigot fittings shall be screwed into ferrules caulked into the fitting. Ferrules and plugs shall be in accordance with Table 54 of CS 188.
- D. Cleanout plugs on copper drainage lines shall be installed in solder-joint fittings having threaded openings provided for the cleanout, or in solder-joint fittings with threaded adapters.
- E. Acceptable Manufacturer - Josam, Smith, Zurn, Wade.

2.8 FLASHING:

- A. Openings in roof for waste vent pipes shall be provided with flexible rubber boots clamped to vent pipe and flashed into roofing. Products and installation shall be watertight and shall be approved by the National Roofing Contractor's Association.

2.9 DIELECTRIC ISOLATORS:

- A. Provide a dielectric isolator at all points of connection between ferrous and nonferrous piping. Isolators shall be made of Teflon or nylon made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection.
- B. Connections may be made with Schedule 80 CPVC nipples, nylon or Teflon bushings selected for the temperatures and pressures of the system.

2.10 VALVES:

- A. All valves shall be designed for 125 psi minimum water working pressure, but in no case less than 150% of the system operating pressure, whichever is greater.
- B. Provide valves with extended necks in insulated piping.
- C. All valves installed in potable systems shall be lead-free in accordance with Federal Government S.3874.
- D. Ball Valves:
 - 1. For size 4- inch and smaller shall be 2 piece, full port brass ball valves with RPTFE seats and packing, blow out proof stem, and sweated or threaded ends.
 - a. Equivalent to Apollo 77FLF.
- E. Check Valves:
 - 1. Check valves 2-inch in size and smaller shall be soldered bronze body, horizontal swing check type with regrindable seat and Buna-N disc.
 - a. Equivalent to Nibco S-413.

2. Check valves 2 1/2-inch in size and larger shall be flanged, cast iron, spring actuated, , horizontal swing check type with stainless steel spring, aluminum bronze bushing, Buna-N bonded to bronze seat, and bronze disc.
 - a. Equivalent to Nibco F-910-B-LF.

F. Butterfly Valves:

1. 2 through 6-inch, 300 psi (2065 kPa) maximum pressure rating, with copper tubing sized grooved ends. Cast brass body to UNS C87850. Aluminum bronze disc to UNS C95500, with pressure responsive elastomer seat. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Certified to the low lead requirements of NSF-372. Victaulic Series 608N.

G. Acceptable Manufacturers – Apollo, DeZurik, Milwaukee, Nibco, Victaulic, Watts.

H. Automatic Balancing Valves:

1. Automatic flow control valves shall be factory set to a rated flow, and shall automatically control the flow to within $\pm 10\%$ of the rated value over a 40 to 1 differential pressure, operating range, (2 to 80 psid). Valves shall have the capabilities and pressure ratings as indicated and conform to this specification.
2. Automatic balance assembly shall include one or more precision sculptured brass or polyphenylsulfone orifi with an elastomeric diaphragm. Each automatic balancing valve shall automatically control the flow rate to within $\pm 10\%$ of its rated flow, over a temperature range of 32 to 225°F, and a pressure differential range of 2 to 80 psid.
3. Inline copper sweat valves 1/2, 3/4, 1, & 1 1/4 inch shall consist of a wrought copper (ASTM B88-83a) housing. Valve bodies shall be suitable for 522 psig working pressure rating per ASME B31.9 Building Services Piping. Flow rates from 0.5 to 25 gpm shall have a differential pressure operating range of 2 to 80 psid.
4. Equivalent to Hays Model 2511, or Victaulic ICSS TA Series 76X.

2.11 WALL HYDRANTS:

- A. Wall hydrants shall be cast bronze, chrome plated nonfreeze type with 3/4-inch inlet and 1-inch copper casing of sufficient length to extend through walls as required to place valve inside the building. Valve rod and seat washer shall be removable through the face of the hydrant. Hydrants shall be furnished complete with adjustment locknuts, union elbows, detachable T-handles, and integral vacuum breaker.
- B. Acceptable Manufacturers - Josam, MiFab, Prier, Smith, Wade, Watts, Woodford, Zurn.

2.12 GAS PIPING:

- A. Underground distribution piping shall be polyethylene piping conforming to applicable State and Federal Standards. The installation shall be completed by personnel meeting the requirements of applicable State and Federal Standards. Risers to above grade shall be anodeless. Joints shall be fusion butt welded. Provide #12 copperclad steel tracer wire equivalent to Copperhead 1230-HS, with wire manufacturer's standard connectors, magnesium anodes and accessories.

1. Underground gas pipe and tubing shall meet or exceed the specifications for ASTM D 2513 and Department of Transportation (DOT) CFR Title 49 Part 192. Material shall Type II Grade P24 as defined by ASTM standard D 1248 and Cell Classification as defined by ASTM standard D 3350. PE gas pipe shall be colored yellow or black with yellow stripe.
- B. Aboveground distribution piping 2-inches and smaller shall be Schedule 40 black steel using malleable iron threaded fittings, wrought steel butt welding fittings or pressed fittings.
 1. Pressed fittings shall be Viega MegaPress Gas Press Fittings. MegaPress Fittings: ½-inch through 2-inch shall conform to ASME B31.1, ASME B31.3, or ASME B31.9 MegaPress fittings with zinc and nickel coating for use with IPS carbon steel pipe conforming to ASTM A53, ASTM A106, ASTM A135, or ASTM A795. MegaPress fittings shall have an HNBR sealing element, 420 stainless steel grip ring, separator ring, and an un-pressed fitting leak identification feature. Sealing elements shall be verified for the intended use. Installation must be in accordance to manufacturer's instructions and specifications.
- C. Aboveground distribution piping 2 1/2-inches and larger, and concealed piping of any size shall be Schedule 40 black steel with wrought steel butt welding fittings, or pressed fittings as specified above.
- D. Valves:
 1. For sizes 1-inch and smaller, provide ball valves, 125 psig WOG.
 2. For sizes larger than 1-inch, provide gas cocks, 125 psi WOG, bronze straight way cocks, flat or square head, threaded ends for 2-inches and smaller, flanged ends for 2 1/2-inches and larger.

2.13 GAS PRESSURE REGULATORS:

- A. Regulators shall be single stage, steel jacketed, corrosion resistant, with vent line extended to atmosphere, threaded ends for 2-inches and smaller, flanged ends for 2 1/2-inches and larger.
- B. Acceptable Manufacturers - Fischer, Maxitrol.

2.14 FIXTURE SUPPLY PIPING SUPPORTS:

- A. Support and position fixture rough-in piping in plumbing chases, shafts, fixture walls or batteries, at each fixture with metal strut framing system or angle iron supports and U- bolt clamps or high impact polystyrene or ABS anchoring channels designed for the purpose. Anchors shall effect positive electrolytic isolation, noise dampening, solid support, and rough-in positioning. See Section 23 20 00 for additional requirements.
- B. Acceptable Manufacturers - Sumner, Pipefix, Channel.

2.15 BACK-TO-BACK FIXTURE MANIFOLD:

- A. Wherever fixtures utilizing both hot and cold water are installed back-to-back on a partition, the hot water shall be on the left and the cold water shall be on the right on both sides of the

partition. Cast bronze manifold fittings designed for the purpose, and to offset around stack may be used.

- B. Acceptable Manufacturers - Precision Plumbing Products "BAC 2 BAC", or approved equal.

2.16 SHOCK ABSORBER:

- A. Shock absorbers shall be factory fabricated stainless steel casing and bellows with working pressure of 250 psi, bellows precharged with nitrogen. Construction shall be in accordance with Plumbing and Drainage Institute Standard PDI-WH201, ANSI A-11, 2.26.1, and ASSE 1010.
- B. Acceptable Manufacturers - Josam, MiFab, Smith, Wade, Watts, Zurn.

2.17 PLUMBING FIXTURES, GENERAL:

- A. Provide plumbing fixtures scheduled, at locations and mounting heights indicated on architectural drawings.
- B. Provide fixture, trim and equipment specified or of similar quality, design, capacity, appearance and function by acceptable manufacturer listed.
- C. Provide required trim for each fixture including faucets, stops, drains, tail pieces, traps and escutcheons.
- D. Fixtures fitted to walls shall have backs ground square and true. Caulk juncture of fixture with wall or floor as directed by the Architect.
- E. Exposed Pipe - Exposed flush, waste and supply pipes at fixtures shall be chromium plated brass pipe, iron pipe size.
- F. Vandalproofing - Provide vandalproof fittings for all fixtures.
- G. Acceptable Manufacturers -
1. Fixtures - American Standard, Crane, Gerber, Kohler, Sloan, Toto, Zurn.
 2. Stainless Steel Sinks (self-rimming) - Elkay, Just, Kohler, Kindred.
 3. Faucets and Drains - American Standard, Bradley, Chicago, Delta, Eljer, Elkay, Gerber, Kohler, Powers, Sloan, Speakman, Symmons, Zurn.
 4. Supplies, Stops and Traps - Central, Crane, Dearborn, Eljer, McGuire.
 5. Closet Seats - Church, Beneke, Olsonite, Sperzel.
 6. Carriers - Josam, MiFab, Smith, Wade, Watts, Zurn.
 7. Service Sinks - Florestone, Fiat, Stern-Williams.
 8. Floor Drains - Josam, MiFab, Smith, Wade, Watts, Zurn.

2.18 PIPE HANGERS AND SUPPORTS:

- A. See Section 23 01 00.

2.19 WATER HEATER - POWER DIRECT-VENT, GAS FIRED, STORAGE TYPE:

- A. Provide AGA approved storage water heater as scheduled, with welded steel tank, polyurethane closed cell insulation, protective sheet metal jacket with baked enamel finish, fully submerged glass-lined condensing heat exchanger, controls, non-sacrificial powered anode rod(s) and temperature and pressure relief valve. Provide water heater with ASME rating when scheduled and for all models with an input rating of 200,000 BTUH or greater.
- B. The heater shall be suitable for sealed combustion direct vertical or sidewall venting using PVC air intake and exhaust pipe for a total of 120 equivalent feet of intake pipe, and 120 equivalent feet of vent pipe.
- C. The tank shall be fully glass or phenolic epoxy plastic lined after assembly and welding of tank. The tank shall be approved for a working pressure of 160 psi minimum. A hand hole cleanout and a drain valve shall be located near the bottom of the tank. The tank assembly shall be covered by a three year limited warranty against failure due to corrosion, metal fatigue or overheating caused by the buildup of scale, film or sediment.
- D. The heat exchanger shall be fully submerged, condensing, spiral shaped, and glass-lined on both water and vent sides to protect against corrosive flue gasses and condensate inside the coil.
- E. The heater shall operate at a minimum of 96% thermal efficiency when tested to ANSI Z21.10.3 "Gas Water Heaters". The heaters standby losses shall satisfy ASHRAE 90.1 standards.
- F. A microprocessor shall control all heater functions including ignition and temperature regulation. Precise temperature control shall be adjustable from 90 to 180 degrees F. A LCD display shall provide detailed operational and diagnostic information in plain English.
- G. The heater shall be completely packaged, requiring only field connection for gas, electrical power, plumbing, and combustion air intake and venting. Provide a thermal expansion tank for the hot water system. Additionally, provide all accessories required to complete water heater installation as scheduled, as indicated on Drawings and as recommended by equipment manufacturer.
- H. Provide a thermometer at the outlet of each water heater.
- I. Acceptable Manufacturers - A.O. Smith, Lochinvar, PVI, State.

2.20 TEMPERATURE AND PRESSURE RELIEF VALVES:

- A. Provide combination temperature and pressure relief valves on each domestic water heater and fired pressure vessel. Valves shall be constructed and rated in accordance with ASME standards, with cast iron bodies, shall be of the diaphragm type, with stainless steel spring, field adjustable, set to relieve above the operating pressure or temperature, but lower than the design pressure of the vessel. Pipe blowoff line full size to 6" above finished floor.
- B. Acceptable Manufacturers - Amtrol, Bell & Gossett, Taco, Watts.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION:

- A. Do not route piping above electrical distribution equipment, per National Electric Code.

3.2 SOIL, WASTE AND VENT SYSTEMS:

- A. Pitch lines at 1/8-inch per foot minimum and 1/4-inch per foot where possible.
- B. Below Grade - Install immediately after excavation, lay pipe so that entire length bears on firm soil, excavate for hubs, do not backfill until installation has been observed.
- C. Above Grade - Install in structure as high as possible. Independently support each length of cast iron. Support steel pipe according to hanger schedule. Support vertical lines at each floor, both horizontally and laterally.
- D. Joints and Fittings for CPVC and PVC plastic piping shall be prepared and solvent welded according to manufacturer's recommendations.
- E. Joints and Fittings for acid waste piping shall be installed according to manufacturer's recommendations.
- F. Vents - Slope up to high point. Support each length of vent pipe independently within structure.
- G. Sanitary Waste Cleanouts - Install cleanouts where required by code and as shown on Drawings. Set floor cleanout covers flush with adjacent finished surface.
- H. Floor Drains, Waste Receptors - Install as shown and connect to cast-iron, deep seal "P" trap. Where a water proof membrane is used, anchor membrane to flange with clamping collar and rustproof bolts.
- I. Drain Lines - Install drain lines from air conditioning equipment, tanks and other items of equipment requiring regular drainage, to waste receptors. Terminate above receptors with elbow turned down when piping is run horizontal to receptor.
- J. Plumbing Fixtures - Rough-in and install plumbing fixtures at height as recommended by the manufacturer unless otherwise indicated on architectural drawings. Caulk perimeter of wall or floor mounted fixture where it meets wall or floor. caulking shall be of type and color as selected by Architect.

3.3 DOMESTIC WATER SYSTEMS:

- A. Below Grade - Install immediately after excavation, do not backfill until installation has been observed, and lay pipe so that entire length bears of firm soil.
 - 1. Site Verification of Conditions:
 - a. Verify that site conditions are acceptable for installation of the PEX potable water system.
 - 2. PEX Piping Installation:

- a. Do not proceed with installation of the PEX potable water system until unacceptable conditions are corrected.
 - b. Install PEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the 2006 Plastic Pipe Institute/Plastic Pipe and Fitting Association/NAHB/PATH Design Guide.
 - c. Joints below grade shall be limited to those required for tees and connection to valves at connections to buildings.
 - d. Minimum horizontal supports are to be installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
 - e. Do not expose PEX tubing to direct sunlight for more than 30 days.
 - f. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
 - g. Protect PEX tubing with sleeves where abrasion may occur.
 - h. Use tubing manufacturer supplied bend supports where bends are less than six times the outside pipe diameter.
 - i. Pressurize tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi (173 kPa) above normal working pressure of the system.
 - j. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32 degrees F (0 degrees C).
 - k. Field Quality Control:
 - 1) Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and one site visit for inspection of product installation in accordance with manufacturer's instructions.
- B. Above Grade - Run level as high as possible in building structure, install hangers per schedule, allow for expansion and contraction, and anchor where required. Separate hot and cold pipes, with 6-inch minimum clear space between piping. Install 3/4-inch hose end drain valve at low points. Install ball valve at each plumbing fixture or group of fixtures, and at each point of connection to equipment. Allow access to equipment, for removal and servicing of pumps or equipment without draining system.
1. PEX Piping Installation:
 - a. Install PEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the 2006 Plastic Pipe Institute/Plastic Pipe and Fitting Association/NAHB/PATH Design Guide.
 - b. Exposed PEX piping shall be neatly installed plumb and parallel to building surfaces, and supported to eliminate sags and deflections.
 2. Copper Piping Installation:
 - a. For slabs on grade, copper pipe shall be separated from sand fill beneath poured concrete by a minimum of 6 inches of soil backfill.
 - b. Isolate copper pipe from concrete at all locations where piping penetrates concrete or masonry construction.
- C. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections,

and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

- D. Viega ProPress connections: Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. Pipe shall be approved by manufacturer for use with fittings. Piping shall be square cut, properly deburred, and cleaned. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
- E. Connections to equipment:
1. Connect to each plumbing fixture.
 2. Connect to each hydrant.
 3. Provide valved connections to each piece of kitchen equipment or owner-provided equipment requiring water connection. Provide pressure regulators, pressure reducing valves, vacuum breakers, shock arrestors and other accessories as required for equipment supplied.
 4. Provide unions or flanged connections at each piece of equipment connected.
 5. Install supply connections to fixtures through wall as high under fixtures as possible.

3.4 WATER HEATER INSPECTION CERTIFICATE:

- A. When required by the Kansas Boiler Safety Act for the storage capacity and/or firing rate of the installed water heater, the Contractor shall be responsible for obtaining an inspection and acceptance certificate from the State Boiler Inspector. The Contractor shall schedule and pay for the inspection, and shall post the certificate(s) in the room containing the water heater.

3.5 SHOCK ABSORBERS:

- A. Install in accessible locations, see drawings. Provide access panels where required.

3.6 DISINFECTION OF WATER SYSTEMS:

- A. General - Disinfect all domestic water systems. Disinfection shall not start until water systems are complete, connections made, and system is flushed out. Upon completion of disinfection, submit certificate and certified bacteriological test report for approval.
- B. Follow the method prescribed by the local Health Department, Building Code Department or water purveyor. In the absence of a prescribed method, follow the procedure outlined in either AWWA C651 or AWWA C652.

3.7 GAS PIPING SYSTEM:

- A. Above Grade - Run level and as high as possible. Install hangers per schedule. Allow for expansion and contraction. Anchor where required. Install Schedule 10 carbon steel welded gas tight pipe casing around piping in concealed vented areas. Pipe casings to be vented to atmosphere. Pipe casings not required in exposed areas.
- B. Below Grade –
 - 1. Use PE pipe, PE fittings, and heat-fusion joints.
 - 2. Installation shall meet the requirements of applicable State and Federal Standards.
 - 3. Install buried gas distribution piping with a minimum cover of 36 inches.
 - 4. Install underground, plastic, gas distribution piping according to ASTM D 2774.
- C. Above Roof - Support piping at no more than 8 feet on center, with manufactured pipe supports: Miro Industries Model 3-R or approved equivalent. The pipe supports shall be a roller-bearing type designed to support piping or conduit, and to absorb thermal expansion and contraction of piping or conduit thus preventing damage to roof membrane. The pipe or conduit shall rest on a polycarbonate resin roller and a glass-filled nylon rod situated in a polycarbonate resin seat.
- D. Connections to equipment - Connect at each appliance or gas using device and provide gas cock unions, and dirt leg.
- E. Tracer Wire Installation:
 - 1. Ground tracer wire at each end of pipe and at all dead ends/stubs per wire manufacturer's instructions.
 - a. Grounding of trace wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20ft of #14 red HDPE insulated copper clad steel wire connected to anode (minimum 0.5 lb.) specifically manufactured for this purpose, and buried at the same elevation as the utility.
 - 2. All new trace wire installations shall be located using typical low frequency (512Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.
 - a. This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.
 - b. Continuity testing in lieu of actual line tracing shall not be accepted.

3.8 TESTING:

- A. Systems shall be tested in accordance with the 2012 International Plumbing Code prior to insulating, covering or concealing this work.
- B. Plug or cap lines for testing and disconnect equipment and devices which may be damaged by excessive test pressures.
- C. Before final connections are made to site sewer and connection of fixtures, all underground drainage piping shall be hydrostatically tested. All openings shall be capped or plugged and the system filled with water to the top of a vertical section of pipe 10 feet high, temporarily connected to the highest point of the underground system. The water shall be allowed to stand in the system for at least 30 minutes prior to inspection. If the water level remains constant and no leaks are found during the period of inspection, the water shall be drained from the system. Final connections shall then be made to the site sewer and the trenches backfilled.

- D. Before any fixtures are connected, all sanitary drain and vent systems, and storm drainage systems above ground, shall be hydrostatically tested. All opening shall be capped or plugged and the systems filled with water. The water shall be allowed to stand in the systems for at least 30 minutes prior to inspection. If the water level remains constant and no leaks are found during the period of inspection, the water shall be drawn off and fixtures, etc., connected. No parts of a system shall be tested with less than 10-foot head of water. No parts of a system using cast iron bell-and-spigot pipe shall be tested with more that a 40-foot head or water, and no parts of a system using screwed piping shall be tested with more than 200-foot head of water. The Contractor shall be responsible for determining the amount of piping he wishes to test at one time, but the above conditions shall not be exceeded.
- E. Before final connections are made to a water supply system, all underground water piping shall be hydrostatically tested and proven tight at a pressure of not less than 100 psi or 50 psi in excess of the working pressure, whichever is greater, at the lowest point in the system. The pressure shall be maintained for at least 1 hour for inspection, the water shall be drained from the system. Final connections shall then be made to the water supply system, and the trenches backfilled.
- F. Before any fixtures or equipment are connected, all domestic water and compressed air systems connected thereto above ground shall be hydrostatically tested and proven tight at a pressure of not less than 100 psi or 50 psi in excess of the working pressure, whichever is greater, at the lowest point in the system. The pressure shall be maintained for at least 2 hours for inspection. If the pressure remains constant and no leaks are found during the period of inspection, the water shall be drained from the systems and final connections shall then be made to the fixtures, etc.
- G. All tests shall be made when there is no danger of freezing, prior to enclosure of any parts of the systems by furrings, suspended ceilings, etc.
- H. Test to demonstrate the capacities and general operating characteristics of all equipment, such as water heating outfits, pumps, water coolers, etc., shall be made under the direction of the Architect at the time of final inspection and under conditions imposed by him. Water heaters having steam or water coils shall be tested with the main heating system in operation.
- I. Gas piping shall be tested in accordance with the requirements of the local building code and the 2012 International Fuel Gas Code.
- J. All tests shall be made in the presence of and results approved by the Architect.
- K. Should any leaks, flaws, or defective materials or equipment be found during the testing operations, such leaks or flaws shall be corrected, and defective materials and equipment replaced. All defective joints shall be remade, and calking or threaded joints will not be acceptable. After corrections have been made, tests shall be repeated until all systems are proven tight and satisfactory. All corrections and retests shall be made at Contractor's expense.

3.9 CLEANING:

- A. See Section 23 01 00.

3.10 COMPLETION:

- A. Complete each piping system in its entirety. Properly support the system, clean the interior surfaces of the pipe by flushing, and disinfecting domestic water piping as specified. Leave systems filled and free from air, and ready for operation and testing.

END OF SECTION 22 00 00

SECTION 23 01 00 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS:

- A. Work covered by this section of these specifications will be accomplished in accordance with the respective drawings, information, or instructions to bidders, general requirements, and the supplementary and general conditions of these specifications. Supplementary conditions, special conditions, addenda, or directive which may be issued by the Engineer shall be complied with.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, sub-contracts, or trades as may be issued for bidding purposes only. The contract documents are combined Architectural, Structural, Plumbing, Heating, Ventilating, and Air Conditioning and Electrical Drawings and Specifications. Drawings and Specifications are on file in the Engineer's office and each Bidder shall thoroughly acquaint himself with the details of the complete set of drawings and specifications before submitting his bid. Drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of drawings, specifications, and addenda issued for this project as no allowance will be made because of the Contractor's unfamiliarity with any portion of the complete set of documents.
- C. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.
- D. Existing remaining systems shall be left in perfect working order upon completion of all new work.
- E. Any equipment which is removed and not reinstalled shall be delivered on site to the Owner, or removed by the Contractor, as directed by the Owner.

1.2 MECHANICAL CONTRACTOR QUALIFICATIONS:

- A. Mechanical Contractor (as a company) and his job superintendent for their portion of the work shall have at least three years of satisfactory experience in completion of projects of comparable size and complexity. Evidence of this experience will be required before approval of the Engineer as being acceptable for their portion of the work.

1.3 SCHEDULE:

- A. The schedule and sequence of work must be carefully coordinated with the Owner, to ensure that all work performed within the existing buildings will result in a minimal amount of noise, dust and disruption to the activities in the existing buildings.

- B. All interruptions of existing services must be coordinated with the Owner, to minimize inconvenience and disruption to the activities in the existing buildings. All interrupted services shall be restored as quickly as possible. All interrupted systems shall be thoroughly cleaned and tested prior to being placed back into operation.

1.4 SCOPE:

- A. The work included under this specification consists of the furnishing of all labor, materials, tools, transportation, services, etc., which are applicable and necessary to complete the installation of the systems specified in these specifications, as illustrated on the accompanying drawings, or as directed by the Engineer.
- B. In general, the various lines and ducts to be installed by the various trades under this specification shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards so as to complete the work in a neat, quiet, and satisfactorily workable manner. Run work parallel or perpendicular to the lines of the building unless otherwise noted.
- C. The construction details of the building are illustrated on the Drawings. Each Contractor shall thoroughly acquaint himself with the details before submitting his bid as no allowance will be made because of the Contractor's unfamiliarity with these details. Place inserts to accommodate the ultimate installation of the pipe hangers in the forms before construction. Concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

1.5 INSPECTION OF SITE:

- A. Contractor shall visit the site, verify existing items shown on plans or specified, and familiarize himself with the working conditions, hazards, existing grades, actual formations, soil conditions, and local requirements involved, and submission of bids shall be deemed evidence of such visit. Proposals shall take these existing conditions into consideration and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

1.6 UTILITIES, LOCATIONS AND ELEVATIONS:

- A. Locations and elevations of the various utilities included within the scope of this work have been obtained from Record Drawings and other substantially reliable sources and are offered separately from the Contract Documents as a general guide only, without guarantee as to accuracy. Contractor shall examine the site, availability of utilities as to their relation to the work; the submission of bids shall be deemed evidence thereof.

1.7 CODES AND STANDARDS:

- A. Workmanship, material and equipment shall be in accordance with Specifications and drawings and in some instances the requirements exceed those required by codes and standards. Where not exceeded, the codes and standards shall be considered as absolute minimum requirements.

1.8 MATERIALS AND WORKMANSHIP:

- A. Materials unless otherwise specified shall be new, free from any defects, and of the best quality of the respective kinds. Like materials used shall be of the same manufacture, model, and quality unless otherwise specified.
- B. Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.
- C. Work under this contract shall be performed by competent workmen and executed in a neat and workmanlike manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials, and the temporary plugging of open lines during construction. At completion, the installation shall be thoroughly cleaned and tools, equipment, obstructions, or debris present as a result of this contract shall be removed from the premises.

1.9 COOPERATION:

- A. Work under these specifications shall be accomplished in conjunction with other trades on this project in a manner which will allow each trade adequate time at the proper stage of construction to fulfill his work.
- B. Maintaining contact and being familiar with the progress of the general construction and timely installation shall be the responsibility of this trade to expedite this contract and avoid unnecessary delays in the progress of other trades.
- C. Should any question arise between trades as to the placing of lines, ducts, conduits, fixtures, or equipment, or should it appear desirable to remove any general construction which would affect the appearance or strength of the structure, reference shall be made to the Engineer for instructions.

1.10 DRAWINGS AND SPECIFICATIONS:

- A. The drawings show diagrammatically the locations of the various lines, ducts, conduits, fixtures, and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building, and in cooperation with other trades and, in all cases, shall be subject to the approval of the Engineer. The Engineer reserves the right to make any reasonable change in the location of any part of this work without additional cost to the Owner.
- B. Should any deviations from the contract documents be deemed necessary by the Contractor, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Engineer for approval.

- C. Exceptions and inconsistencies in plans and specifications shall be brought to the Engineer's attention before bids are submitted; otherwise, the Contractor shall be responsible for the cost of any changes and additions that may be necessary to accommodate his particular apparatus.
- D. Contractor shall lay out his work maintaining lines, grades, and dimensions according to these drawings with due consideration for other trades and verify dimensions at the site prior to any fabrication or installation; and should any conflict develop or installation be impractical, the Engineer shall be notified before any installation or fabrication and the existing conditions shall be investigated and proper changes effected without any additional cost.
- E. Manufactured equipment shown, arrangement of parts, openings in floors, roof or walls are sized for a particular manufacturer's equipment. The Contractor shall verify exact sizes and arrangements required by equipment and in submitting his equipment for approval he certifies that the equipment will fit within the space allotted for it.
- F. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of materials or work. The Engineer does not assume any responsibility either direct or implied, for omissions or duplications by the Contractor and any Sub- Contractor due to real or alleged error in the arrangement of matter in the Contract Documents.

1.11 ENGINEER'S APPROVAL:

- A. In any statement under this Contract where "approval" is required or requested, it is understood that such approval must be obtained from the Engineer in writing before proceeding with the proposal, and an adequate number of copies of such proposal shall be submitted to the Engineer.
- B. The approval by the Engineer of any materials, changes, drawings, etc., submitted by the Contractor will be considered as general only and to aid the Contractor in expediting his work. Such approval as may be given does not in any way relieve the Contractor from the necessity of furnishing the material and performing work as required by the drawings and specifications.

1.12 LOCAL RESTRICTIONS:

- A. Contractor shall become familiar with rules and regulations of the City, County, and State; or any other authority having jurisdiction over this project; and if, in his opinion, any work or materials shown on the drawings or specified do not comply with these rules and regulations as to size, type, capacity, and quality, he should make it known prior to the submission of his bid, which shall be deemed evidence of compliance; otherwise, the Contractor shall be responsible for the approval of work or material; and, in the event that any such authority should indicate disapproval, he shall correct same with materials approved by the Engineer at no additional cost to the Owner

1.13 ELECTRIC WIRING:

- A. The Mechanical Contractor shall erect motors in place ready for power connection and where scheduled or indicated on plans, shall furnish with each such motor a starter of the type specified and deliver it in good condition to the Electrical Contractor for installation. The

Electrical Contractor shall mount such starters as directed, furnishing supporting structure where necessary. Those who furnish motors and equipment shall also furnish with each item necessary instructions and wiring diagrams to the Electrical Contractor. Refer to Electrical Sections of the Specifications to determine in further detail the scope of the electrical work.

- B. Equipment actually installed on the project generally differs slightly from the equipment specified. To avoid incompatible branch service, prepare a list of electrical consuming items being installed in the project under this contract, which lists volts, phase, service factor, etc., of each and every piece of equipment or electrical device. Formally transmit the list to the Electrical Contractor to verify the compatibility of the electric service provided to each item. This coordination shall be completed prior to finalizing equipment and material purchases for the project.
- C. If the Contractor furnishes motors differing in size from those scheduled, he shall notify the Electrical Contractor and make provisions for revised electrical and pay for any changes necessary.

1.14 RESPONSIBILITY:

- A. Contractor shall be held responsible for the satisfactory and complete execution of work included. He shall produce complete finished operating systems and provide incidental items required as part of his work, regardless of whether such item is particularly specified or indicated.

1.15 GUARANTEE:

- A. Contractor shall furnish a written guarantee in triplicate warranting all materials, equipment, and labor furnished by him to be free of all defects, for a period of one year from date of final acceptance by the Owner. He shall further guarantee that all equipment shall meet the characteristics, capacities, and workmanship specified; and should any defects or non-performance of equipment be indicated within the warranty period, the defects and/or equipment will be repaired or made good without cost to the Owner.

1.16 REFERENCE ABBREVIATIONS:

- A. References are made in the various mechanical sections to technical societies, codes, specifications, trade organizations, and regulatory authorities in accordance with the following abbreviations:
 - 1. AABC - Associated Air Balance Council
 - 2. AFE- Air Filter Institute
 - 3. AGA- American Gas Association
 - 4. AMCA- Air Moving and Conditioning Association
 - 5. ANSI- American National Standards Institute
 - 6. ARI- Air Conditioning and Refrigeration Institute
 - 7. ASHRAE- Society of Heating, Refrigeration and Air Conditioning Engineers
 - 8. ASME- American Society of Mechanical Engineers
 - 9. ASTM- American Society for Testing and Materials

10. AWSC- American Welding Society Code
11. AWWA- American Water Works Association
12. CISPI- Cast Iron Soil Pipe Institute
13. CTI- Cooling Tower Institute
14. FM- Factory Mutual
15. FS- Federal Specification
16. IRI- Industrial Risk Insurers
17. ISO- Insurance Services Organization
18. NAFM- National Association of Fan Manufacturers
19. NCPWB(MCAA)- National Certified Pipe Welders Bureau (Mechanical Contractors Association of America)
20. NFC- National Fire Codes
21. NFPA- National Fire Protection Association
22. PDI- Plumbing and Drainage Institute
23. SBI- Steel Boiler Institute
24. SMACNA- Sheet Metal and Air Conditioning Contractors National Association
25. UL- Underwriters Laboratories, Inc.

1.17 SHOP DRAWINGS AND DATA TO BE SUBMITTED:

A. SUBMITTALS WHICH DO NOT MEET THE FOLLOWING REQUIREMENTS WILL BE IMMEDIATELY REJECTED WITHOUT FURTHER REVIEW!!!

1. Catalog cutsheets and brochures will be preceded by a neatly arranged cover sheet having ample room for shopdrawing stamps and bearing the following information in a prominent, immediately visible location and size:
 - a. Equipment name or number as referenced in the contract Documents (example: "AHU-A" or "Type A" light fixture).
 - b. All options or accessories provided.
 - c. Applicable Specification section and paragraph numbers.
2. Substitutions -
 - a. Cross reference individual manufacturer and catalog numbers of substitute products to those of specified material.
 - b. Prior to requesting permission to use substitute or alternate products, the Contractor shall investigate and make certain that the product-
 - 1) Conforms with the standard of performance and quality specified.
 - 2) Will physically fit in the space allocated, with sufficient access and maintenance space.
 - 3) Involves no additional costs to the Owner or extended construction time.
 - c. Should the use of a substitute product entail any changes in details or construction, the changes and information documenting the complete coordination with all affected trades shall be submitted prior to approval of substitution.
 - d. Provide with requests for permission to use substitute or alternate products, drawings, specifications, samples, performance data and other information as may

be required to assist in determination of acceptability of the product. The burden of proof is the Contractor's responsibility.

3. All similar or related items shall be submitted together under one cover sheet (i.e. fixtures, insulation, valves, equipment). Do not piece-meal submittals!!!

B. Equipment Items:

1. Submit manufacturer's certified data relative to equipment required for the installation of the HVAC, plumbing and fire protection systems.
2. Submit adequate engineering data on each piece of equipment to allow a careful check of compliance with the technical requirements of the Contract Documents. Clearly indicate on submittal data the manufacturer's name, piece number, equipment capacity, and other applicable technical data.
3. Submit the following data for Mechanical Systems-
 - a. Foundations, Supports, Hangers, Inserts.
 - b. Insulation.
 - c. Ventilation and Air Conditioning Equipment, Specialties and their Control Systems.
 - d. Plumbing Equipment, Piping, Fittings and Valves
 - e. Special Products Furnished by Mechanical Trades.
 - f. Openings, Special Framing and Access Doors.
 - g. Data for Testing and Balancing of the Heating, Air Conditioning and Ventilating Systems.
 - h. Installation Instructions - Submit Manufacturer's Printed Installation Instructions.
 - i. Temperature Controls.
 - j. HVAC Piping, Fittings and Valves
 - k. Air Devices.

1.18 INSTRUCTIONS:

- A. The Contractor shall furnish the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation, and maintenance, including pertinent safety requirements of the equipment in each mechanical system. Each instructor shall be thoroughly familiar with all parts of the installation.
- B. The Contractor shall be responsible for videotaping all training sessions and shall submit two copies of the training videos on DVD discs.
- C. The number and length of training sessions shall be as specified in the various Sections of the Specification.
- D. These requirements are supplemented by requirements for specific equipment or systems in the various Sections of the Specification.

1.19 OPERATING AND MAINTENANCE MANUALS:

- A. Bind in looseleaf binders with the words, "Operating and Maintenance Manual" and the Project identification imprinted on the cover. Prepare four complete sets of records for the Owner, with table of contents, index, and tabbed Section dividers.
- B. During the construction period, accumulate the following for inclusion in the Operating and Maintenance Manuals-
 - 1. Copies or warranties and guarantees on each piece of equipment installed.
 - 2. Fixture brochures.
 - 3. Wiring and Control Diagrams.
 - 4. Approved Shop Drawings.
 - 5. Operating instructions for-
 - a. HVAC Systems.
 - b. Temperature Controls.
 - 6. Recommended maintenance procedures.
 - 7. Lists of major items of equipment with name, address, and telephone number of each local representative.
- C. Submit the manuals for approval at approximately 75 percent job completion.
- D. Each manual shall consist of-
 - 1. Complete description of each item of equipment and apparatus furnished and installed - including ratings, capacities, and characteristics.
 - 2. Fully detailed parts list, including all numbered parts of each item of equipment and apparatus furnished and installed.
 - 3. Manufacturer's printed instructions describing operation, servicing, maintenance and repair of each item of equipment and apparatus.
 - 4. Typewritten record of all tests made of materials, equipment, and systems. All such records shall state the date tests were conducted, the names of all persons making and witnessing the tests, and citing any unusual conditions relevant to the tests.

1.20 RECORD DRAWINGS:

- A. Accumulate Record Drawings during the construction of the Project. Keep one set of blue-line Contract Drawings at the job site at all times, and mark changes, rerouting or modifications which occur, clearly on the Drawings with dimensions.
- B. At completion of the job, deliver Record Drawings to the Engineer. Record Drawings shall be submitted for approval prior to final payment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer's names and catalog numbers are scheduled or specified for the purpose of establishing standard of design, quality, appearance, performance and serviceability, and not to limit competition. Scheduled products (as may be modified by detailed specifications) are those selected as the basis for system design with respect to physical size and space arrangements, required capacity and performance characteristics, and the product quality intended.
- B. The Drawings indicate specified products physically arranged in the spaces, as cataloged by specific manufacturers, generally as listed in the Equipment Schedules.
- C. Listed "Acceptable Manufacturer's" are those considered capable of manufacturing products conforming to detailed Specifications, and as such, are invited to compete on an equal basis provided the offering is comparable in every respect to scheduled or specified products and actually conforms to the detailed Specifications and Schedule requirements. Listing herein as "acceptable manufacturers" does not imply "accepted", "approved", or "prior approval", or any other such connotation. All product offerings must be submitted for approval after Contract award.
- D. Vendors are invited to submit material or equipment bids to bidding Contractors on any comparable equivalent product, whether or not the manufacturer of such product is listed herein as an "acceptable manufacturer". Such product bids should clearly indicate offerings that are not listed as "acceptable manufacturers". In the event a bidding Contractor, after satisfying himself that such unlisted product is in fact "equal" to the specified product with respect to design, quality, performance and arrangement (space requirements), and the Contractor desires to furnish that product on the Project, he may request the name of the manufacturer be added to the list of acceptable manufacturers by addendum prior to bid time.
- E. At a bidder's request, an unnamed manufacturer's equipment will be considered to determine additional "acceptable manufacturers" if a request is made in writing no later than ten days prior to the bid opening. If such requests are found acceptable, an addendum will be written listing additional acceptable manufacturers. Consideration will be given only to requests of bona fide bidders (Contractors), not to those received from vendors.
- F. Manufacturers of materials and equipment shall be as specified, scheduled, or as listed in each respective product Specification Article.

2.2 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS:

- A. Materials and adhesives used throughout the mechanical systems for insulation, acoustical lining, filters, ducts, flexible connections, and jackets or coverings regardless of kind, or for piping or conduit system components, shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. If such materials are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50. (Note: materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard or where specifically exempted in the body of these Specifications).
- B. "Flame Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255, ASTM E84,

Underwriters Laboratories, Inc., Standard". Such materials are listed in the Underwriters Laboratories, Inc. "Building Materials List" under the heading "Hazard Classification (Fire)".

2.3 IDENTIFICATION OF PIPING, AND EQUIPMENT

- A. Identify mechanical equipment in main mechanical room only with nameplate bearing equipment name, number, module, and room(s) served (use room numbers on architectural plans), using bevel edges, 1/16-inch thick, 1 1/2- inch white laminated Bakelite with engraved black letters, 1/2-inch (double line) or 7/8-inch (single line) high, permanently mounted on the equipment in a conspicuous place with screws.
- B. Markings - Identify each piping system in main mechanical room and immediately inside tunnel access doors with the direction of flow (where applicable) indicated by legends and flow arrows. The markings shall be applied after all cleaning of the piping and insulation is completed. Identify with semi rigid mechanically applied plastic marked bands with background color coded per ANSI A13.1. Color of lettering and flow arrow shall be black. Marker material shall completely encircle the pipe when smaller than 8-inch ips.
1. Provide 1/2-inch letters, 8-inch long color field on outside diameters less than 1 1/2-inch.
 2. Provide 3/4-inch letters, 8-inch long color field on outside diameters of 1 1/2 to 2-inch.
 3. Provide 1 1/4-inch letters, 12-inch long color field on outside diameters over 2-inch, but smaller than 8-inch.
 4. Provide 2 1/2-inch letters, 24-inch long color field on outside diameters of 8-inch to 10-inch.
 5. Provide 3 1/2-inch letters, 36-inch long color field on outside diameters larger than 10-inch.
- C. The legend and flow arrow shall be applied at each valve location, and at each point where piping enters or leaves a wall, partition, bulkhead, cluster of piping or similar obstruction..
- D. Variations or changes in locations and spacing shall be made to meet conditions.
- E. Wherever two or more pipes run parallel, the printed legend and other markings shall be applied in the same relative locations so as to be in either vertical or horizontal linearity, whichever the case may be.
- F. The markings shall be located so as to be conspicuous and legible from any reasonable point.
- G. Standard pipe and conduit identification symbols.
1. CW - Domestic Cold Water.
 2. HW - Domestic Hot Water.
 3. THW - Tempered Domestic Hot Water.
 4. HWR - Domestic Hot Water Recirculation.
 5. SS - Sanitary Sewer.
 6. SV - Sanitary Vent.
 7. ST - Storm Drainage Piping
 8. GAS - Natural Gas.
 9. CHS – Chilled Water Supply.
 10. CHR – Chilled Water Return.

11. HS – Heating Water Supply.
12. HR – Heating Water Return.
13. REF – Refrigerant.
14. D - AC Condensate Drain.

H. Underground Warning Tapes for Buried Lines-

1. Provide 3-inch wide metallic core brightly colored polyethylene detection tape, shallow buried in the trench above nonmetallic pipes, serving the dual purpose of line location and identification. The tape shall be easily detected by any commonly used metal detector and shall bear a printed message (continuous along entire length) describing the contents of the line beneath.
2. Provide 6-inch wide brightly colored polyethylene tape, shallow buried in the trench above metallic pipes, to identify the contents of the line beneath. The tape shall bear a printed message (continuous along entire length) describing the type of the buried line and its contents.

I. Provide valve tags schedules and valve charts for each piping system consisting of Schematic Drawings of piping layouts along with a valve list, showing and identifying each valve by number, service, and location and describing its function. Upon completion of the Work, mount two copies of each chart, sealed to rigid backboard with clear lacquer, placed under glass and framed, on the wall. Two additional unmounted copies shall be delivered to the Owner.

J. Valve Tags - Provide 1 1/4-inch x 1 1/4-inch square laminated plastic name tags with 1/4-inch engraved letters for all valves, with black letters on white tags, marked for type of service intended. Attach tags to valve handles by "S" hooks.

K. Nameplates and tags shall correspond to the Record Drawings.

L. Submit complete details of identification legends, color fields, and sizes, coordinated between trades.

M. Acceptable Manufacturers - Seton Nameplate Corporation, W.H. Brady, Westline.

2.4 BEARINGS

A. All bearings supplied to the Project, regardless of supply responsibility or applications as integral parts of machinery, shall be standard catalog items and interchangeable with those of manufacturers currently represented in the local trade area with replacements stocked locally. Ball bearings shall be radial or thrust design, sealed and enclosed in a dust and moisture proof housing, and selected in accordance with AFBM Rating B-10 for at least 200,000 hour operating life as applied. Grease lubricated bearings shall be arranged for regreasing through alemite fittings located outside machinery enclosures in a convenient location, with grease relief fittings in the bearing housing to prevent overgreasing or seal rupture.

B. Acceptable Manufacturers - Andrews, Dodge, Fafnir, Hyatt, Link-Belt, MRC, McGill, New Departure, Sealmaster, SKF, Shafer, Rollway, Thompson, Timken, Torrington.

2.5 ELECTRIC MOTORS

- A. Shall conform to the requirements of IEEE, NEMA, and shall have voltage, phase, frequency and service as scheduled.
- B. Each item of motor driven equipment shall be furnished complete with the motors, drives and control equipment, including remote pilot devices as required to perform the specific function for which it is intended.
- C. Motors shall be sleeve or ball bearing type selected for quiet operation, shall be manufactured for general purpose duty, with each bearing accessible for lubrication, and designed for the load imposed by the drive.
- D. Motors 1/2 horsepower and larger shall have bearings with pressure grease lubrication.
- E. Motors connected to drive equipment by belt shall be furnished with adjustable slide rail bases except for fractional horsepower motors which shall have slotted bases. Motor leads shall be permanently identified and supplied with connectors.
- F. Provide open dripproof enclosures for motors located indoors in dry locations, and splashproof enclosures in wet locations. Motors to be installed outdoors shall be totally enclosed fan cooled.
- G. Unless otherwise scheduled, motors ½ horsepower and smaller shall be electronically commutated motors, designed for 120 volt, single phase, 60 Hz alternating current.
- H. Unless otherwise scheduled, motors larger than ½ horsepower shall be premium efficiency and shall meet the requirements for premium efficiency motors as defined in NEMA MG 1, latest edition. Minimum efficiencies and power factors shall not be less than listed in NEMA MG 1. The motor nameplate shall bear the designation "PREMIUM EFFICIENCY" as well as the efficiency and power factor.
- I. Unless otherwise scheduled, motors 1/2 horsepower and larger shall be squirrel cage induction type, for scheduled voltage, 3 phase, 60 Hz alternating current.
- J. Each motor shall be free from magnetic hum, designed for quiet operation.
- K. Each motor shall be suitable for the brake horsepower of the driven unit, rated with 1.15 minimum service factor, with the temperature rise not to exceed NEMA standards and shall be capable of withstanding momentary overloads of 25 percent without injurious overheating.
- L. Electrical Specifications - Copper windings, winding insulation system NEMA Class B or better, wound for standard voltages. Motors shall conform to NEMA Design B as a minimum.
- M. Mechanical Specifications - Frame dimensions conform to NEMA standards for "T-Frame" motors. Frame construction of motors larger than NEMA frame 145T of cast-iron or extruded aluminum construction and those of NEMA frame size 145T and smaller may be fabricated steel type. Nameplates shall be stainless steel. Grease lubricated ball or roller bearings shall be supplied unless otherwise specified. On NEMA frame sizes 182T and larger make provisions for regreasing by use of removable grease plugs.
- N. Acceptable Manufacturers - Allis Chalmers, Baldor, Century, General Electric, Ideal, Lincoln, Louis Allis, Marathon, Reliance, U.S., Wagner, Westinghouse.

2.6 MOTOR STARTERS

- A. Except where otherwise specified or scheduled, each starter shall be furnished by the supplier who furnishes the equipment it controls.
- B. Provide a manual or magnetic starter for each motor. Where such devices are included in an "Equipment Control Schedule", they shall be as scheduled. Otherwise, they shall be as recommended by the equipment manufacturer.
- C. Magnetic starters shall include overload protection for each phase wired with normally closed contacts in series control circuit ahead of any other control contacts on the control side of the solenoid coil, and no contacts between the other side of the solenoid coil and the control power source. Motor starters shall conform to NEMA Standards for Industrial Control for 3 phase motors, No. 1C-1, with 120 volt (maximum) control circuit and control power transformer.
- D. Where individual starters and disconnect switches (or circuit breakers) are indicated to be in the same location, furnish combination devices in a common housing. Fused disconnects shall have rejection type fuse clips and Class RK-1 fuses.
- E. In every instance where magnetic starters are not required, furnish manual starters for fractional horsepower single phase motors - "ON-OFF", snap switch type with soldered ratchet overload protection.
- F. When interlocking or automatic control of single phase motors is indicated or required, the motors shall be furnished with magnetic across-the-line starters.
- G. When interlocking or automatic control of electric heaters is indicated or required, the heaters shall be furnished with contactors. Provide control power transformers as required to maintain control circuit voltages not exceeding 120 volts.
- H. Provide with each magnetic starter a reset button, pilot light, and HAND-OFF-AUTO switch, heavy duty type, mounted in starter cover. Provide field reversible (normally open or normally closed) auxiliary contacts required for interlocking but in no case less than two per starter.
- I. Acceptable Manufacturers - Allen Bradley, Cerus, Cutler-Hammer, General Electric, I-T-E, Square D, Westinghouse.

2.7 ACCESS DOORS:

- A. Furnish, for installation under appropriate Section of the Work, access doors at each point required to provide access to concealed valves, dampers, damper operators, and other devices requiring operation, adjustment, or maintenance.
- B. Shall be 16 gage steel, with mounting straps, concealed hangers, and screwdriver locks, designed for the doors to open 180 degrees, minimum.
- C. Access doors installed in fire walls or partitions shall be UL labeled to maintain surfaces.
- D. Provide prime coat finish for installation in ceilings or painted or unfinished surfaces.

- E. Provide polish chrome plate finish for installation in unpainted finished walls.
- F. Acceptable Manufacturers - Baldwin, Hannon, Josam, Miami, Carey, Milcor, Titus, Wade, Walsh, Zurn.

2.8 METAL STRUT FRAMING SYSTEMS:

- A. Shall be a basic adjustable slotted steel framing system consisting of components specifically designed for the support of mechanical and electrical systems. Parts shall include modular type channels, available with or without bolt holes, knockouts, or slots, with fittings and hardware requiring no welding, drilling, or other complex fabrication techniques. Basic attachment to channel shall be by means of spring mounted gripping nuts with serrated grooves, and bolts.
- B. Available accessories shall include brackets, baseplates, rod connectors, pipe and conduit straps, pipe and conduit hangers, beam clamps, cable clamps, concrete inserts and closure strips.
- C. Loading shall not exceed manufacturer's published load capacities for parts, connections, and assemblies for the actual spans involved.
- D. Shall be UL listed for the purpose when utilized as electrical raceway.
- E. Acceptable Manufacturers - B-Line, Elcen, F and S, Kindorf, Power Strut, Unistrut.

2.9 SLEEVES, INSERTS, ANCHORS AND SUPPORTS:

- A. Provide in concrete, carpentry or masonry construction, hangers, sleeves, expansion bolts, inserts, supporting steel, or other fixtures necessary for the support of pipe, equipment and devices furnished under each Section of the Specifications.
- B. Provide each pipe, conduit, or duct passing through walls, floors, ceilings or partitions with sleeves having internal dimension approximately 1-inch larger than the outside dimension (including installation) of pipes, conduits or ducts.
- C. Sleeves through interior partitions and floors shall be no less than 22 gage galvanized steel, set flush with the finished surfaces.
- D. Sleeves through mechanical room floor shall match existing.
- E. Attachments to structure shall be by means of beam clamps wherever practicable.
- F. Acceptable Manufacturers - Grinnell, Hilti, Phillips, or Thunderline.

2.10 FIRE STOPPING:

- A. Seal annular spaces between sleeves and penetrating materials in fire rated floors, ceilings, and walls with fireproof and waterproof silicone elastomer applied in accordance with the manufacturer's published instructions. Multiple penetrations shall be sealed with silicone caulking. Seal material shall be UL classified for use in fire rated penetration seals, and shall be

applied in the manufacturer's recommended thickness for the fire rating of the penetrated structure in accordance with ASTM-E-814 requirements.

- B. Acceptable Manufacturers - Dow Corning, General Electric, Hilti.

2.11 WATERPROOFING:

- A. Seal penetrations of wet or potentially wet structures, floors, exterior walls, etc., other than those requiring fire stopping, with sealant to prevent moisture leakage. Apply sealing material (calking) in accordance with manufacturer's published instructions.
- B. Product Research and Chemical Co. "Poly-Sulphide Sealant" PRC- 5000.

2.12 AUXILIARY STRUCTURAL SUPPORTS:

- A. Provide auxiliary structural supports as necessary to support mechanical systems from the building structure. Coordinate with structural drawings. Supporting members shall be metal strut framing or standard structural shapes, designed to support imposed loads with a working stress no greater than 25 percent of ultimate stress values of the members, and articulation with the building structure without exceeding structural limitations at the point of attachment to the building structure. Prepare calculations and Shop Drawings of each such support and submit for acceptance. Begin no work until receipt of acceptance from the structural engineer.

2.13 ESCUTCHEONS:

- A. Provide escutcheons or 22 gage minimum painted galvanized sheet metal wall flanges (in event standard manufactured product does not exist) for mechanical or electrical penetrations of floors, ceilings, walls or partitions. Escutcheons shall be sized to enclosed the outside of the penetration sleeve and fit snugly to the pipe (or over outside of insulation) of insulated lines. Both exposed surfaces of such penetrated elements shall be fitted with escutcheons which shall both afford a finished appearance and prevent passage of vermin.
- B. Except where otherwise specified, escutcheons shall be one- piece (where practicable) or split, hinged, stamped brass type designed to fit the pipe, and to cover the terminating pipe sleeve, in chrome plated finish, with securing device to hold the escutcheon tight to the pipe.
- C. Use deep escutcheon on each sleeve set in a waterproof concrete floor.
- D. Acceptable Manufacturers - Beaton and Corbin, Grinnell, Sweet and Donaldson.

2.14 ROOFTOP EQUIPMENT SUPPORTS AND PIPE CURBS:

- A. Provide insulated, leakproof equipment supports and pipe curbs approved by the National Roofing Contractor's Association for roof mounted equipment, pipe, or conduits. Supports shall be prefabricated of continuous welded 18 gage minimum galvanized steel, 12-inch minimum height, mitered corner seams, integral cant and base plate, 2 x 4 fire resistant treated wood

nailer, and 18 gage counterflashing. Provide integral internal reinforcing necessary to support imposed load, but no less than 600 pounds per linear foot of perimeter.

- B. Provide raised cant, thickness to match thickness of roof insulation.
- C. Top surface shall be level. Provide pitched base where installed on pitched roof.
- D. For pipe curbs, coordinate conduit requirements with Division 26, to provide required openings in a single curb.
- E. Acceptable Manufacturers - Pate, Roof Products Systems, Stiles, Thycurb.

2.15 FLASHINGS:

- A. Furnish weatherproof flashings for mechanical system related openings through the roof and walls.
- B. Furnish roof flashing for round and rectangular openings, pipes, vents, machinery, devices, or ducts. The flashings shall be constructed to terminate not less than 12-inches above the roof. Provide suitable counterflashing constructed from the same material as the flashing.
- C. Furnish flashings for mechanical curbs, and furnish and install counterflashing at each.

2.16 BALANCING TAPS (TEST PLUGS)

- A. Universal test connections for use either with thermometer or gage consisting of a brass case with cap and seal, 1/4-inch ips male thread connector and neoprene valve for insertion of stab connector.
- B. Pressure rating of fittings shall be equal to or greater than the piping system in which installed.
- C. Furnish 2 each gage adapter fittings and thermometers (25-125 and 50-500°F).
- D. Acceptable Manufacturers - Fairfax, Peterson (Pete's Plug), Sisko.

2.17 PIPE HANGERS AND SUPPORTS:

- A. Hold piping in place by accepted hangers, supports and anchors, designed to support weight of pipe, weight of fluid and weight of pipe insulation. Arrange hangers to prevent transmission of vibration from piping to building and supports. Allow clearance for application of specified vapor sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings. Uninsulated copper or brass pipe or tubing shall be isolated from ferrous hangers or supports. Piping shall not be supported from roof decking. Furnish and install angle members to span steel joists or distribute load.
- B. Suspend and support horizontal and vertical piping from the structure with hangers and metal strut framing system or structural steel supports, spaced as scheduled. Furnish necessary accessories, nuts, lock nuts, bolts, rods and devices to allow installation to freely expand and

contract. Hangers shall be formed steel clevis type, unless otherwise specified, with adjustable attachment to hanger rod. For copper or brass pipe, use plastic sheathed hangers to eliminate all possibility of galvanic action between hanger and copper tubing. Pipe hangers shall fit over vapor sealed insulated piping.

1. Clevis - Grinnel Fig. 260 or 590.
 2. Uninsulated copper tubing - Grinnell Fig. CT-99C.
- C. Where pipe exceeds maximum loading recommended for clevis type hanger and for attachment to vertical pipes, provide steel pipe clamps.
1. Double bolt pipe clamps - Grinnell Fig. 295.
 2. Riser clamps - Grinnell Fig. 261.
 3. Copper tubing riser clamps - Grinnell Fig. CT-121-C.
- D. Provide trapeze hangers where several pipes can be installed parallel and at same level. Trapeze of standard structural steel shapes sized to support load and drilled for rod hanger at each end.
1. Grinnel Fig. 46.
- E. Use roller supports with cast iron adjustable bases, where provision for expansion is required.
1. Grinnell Fig. 274.
- F. For hanger rods on piping 3/4-inch thru 2-inch inclusive, use 3/8-inch thru 3 1/2-inch inclusive, use 1/2-inch rods; for 4- inch thru 5-inch inclusive, use 5/8-inch rods; for 6-inch, use 3/4-inch rods; for 8-inch thru 12-inch, use 7/8-inch rods; and for piping larger than 12-inches, use 1-inch rods.
- G. Provide additional steel members required for hanging piping systems in areas with special conditions, or where vertical or horizontal structural steel supports are required other than those provided in the structure.
- H. Provide oversize hangers with hanger shields or blocking the same thickness as insulation to pitch insulated pipes accurately at time of installation.
- I. C-Type hangers on sprinkler piping shall have lock nuts.
- J. Attach supporting rods to concrete by drilled anchors or inserts placed before concrete is poured.
- K. Provide lateral bracing for supporting rods over 18-inches long braced at every fourth hanger with diagonal bracing attached to slab or beam.
- L. Attach supporting rods to precast structural members on sides by expansion bolts located above steel reinforcing at minimum of 6-inches above the bottom. Power driven devices shall not be used.
- M. Floor Supports - Provide for supporting horizontal piping from floors with cast-iron pipe rests, with pipe nipples to suit. Fasten to floor. Where provision for expansion is required, provide

pipe roll stands, without vertical adjustment. Provide concrete or steel pipe piers; fasten stands to piers.

- N. Wall Supports - Provide for supporting horizontal piping from wall with steel J-hook for pipe located close to wall and no larger than 3-inch pipe. For greater loads, up to 1500-pound maximum loading, provide welded steel bracket.
- O. Use inserts of drilled anchors in concrete construction, use beam clamps in steel construction.
- P. Hanger spacing schedule, except for nonmetallic, cast iron, or fire protection systems, shall be as follows:
- | | | |
|----|----------------------|---------|
| 1. | 1/2 and 3/4-inches | 6-feet |
| 2. | 1-inch | 7-feet |
| 3. | 1 1/4-inch | 8-feet |
| 4. | 1 1/2-inch | 9-feet |
| 5. | 2-inch | 10-feet |
| 6. | Larger than 2-inches | 12-feet |
- Q. Furnish miscellaneous steel necessary to support piping systems, including those accessories required for trapeze or group hanging.
- R. Acceptable Manufacturers - B-Line, Grinnell, Burt Patterson, Elgen, F and S Fee and Mason,, Michigan, Modern.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT:

- A. Protect equipment from physical damage and deterioration after it is delivered to the Project, and during the installation period prior to Owner acceptance.
- B. The equipment shall be kept clean. Motors and electrical devices shall be covered with suitable materials to prevent dirt or dust accumulation within equipment. Machinery and devices shall be properly oiled and maintained to prevent rusting and deterioration.
- C. Repair scratches, mars, or paint deterioration.

3.2 EXCAVATION AND BACKFILL

- A. Perform excavation and backfill required for the installation of underground pipe, ducts, equipment and devices.
- B. Cut trenches true and straight and grade bottom to afford uniform bearing of barrel on firm soil. Stack the excavation material in a suitable location. Shore trenches and excavated areas as required for safety, and for security of adjacent earth and structures.
- C. Cut through walks, roads, and other structures as necessary for the installation.

- D. Install underground mechanical piping and ducts with a minimum cover of 24-inches from finished grade, or as detailed on plans. Pipes carrying water shall be installed a minimum of six inches below the frost line.
- E. Trench width at and below top of pipe shall result in horizontal clearance between trench wall and barrel on both sides.
- F. Pipes smaller than 18-inch - at least 6, but no more than 8-inch clearance.
- G. Prepare trench bottom. Dig out of joints. Lay pipe in trench so that entire length bears on firm soil. No part of bell fittings shall support the remainder of the pipe.
- H. Provide embedment where indicated or if trench is unsuitable for support. Cut excavation a minimum of 6-inches below the required grade. A 6-inch bed of sand shall then be placed and properly compacted to provide accurate grade, and uniform bearing throughout the length of pipe or conduit. The sand shall consist of clean, natural, washed sand with particle sizes which will pass through a 3/8-inch screen, 90 percent through a quarter inch screen, and no more than 25 percent through a No. 50 screen.
- I. The backfilling shall not be placed until the Work has been inspected, tested and accepted.
- J. Backfill material shall be free of cinder or rocks, and free of clods or lumps larger than 1-inch, up to 12-inches above top of pipe, and 2-inches in remainder. If the excavated material is not suitable, provide adequate material from other locations.
- K. Backfill by installing clean earth in accordance with the above Specifications in layers no more than 6-inches thick, tamping (and wetting down, if necessary). Hand place and tamp each layer of initial backfill in 4-inch layers up to pipe centerline, and in 6-inch layers up to 12-inches above the top of pipe. Complete backfill to grade and create a substantial, well-compacted trench to 95 percent compaction by the standard Proctor test.
- L. Surplus earth or materials remaining after backfilling shall be removed from the site.
- M. Repair utilities, lines, walks, and roads, and other surfaces and structures damaged by these operations to match conditions existing prior to excavation.

3.3 EQUIPMENT SPACE:

- A. The Drawings indicate specified products physically arranged in the spaces, as cataloged by specific manufacturers, generally as listed in the Equipment Schedule.
- B. Coordinate the exact physical space requirements for equipment and servicing of equipment actually purchased for each item of equipment involved.
- C. Drawings show pipe and ductwork diagrammatically.
- D. Adhere to Drawings as closely as possible in layout of work.
- E. Vary run of piping, run and shape of ductwork and make offset during progress of work as required to meet structural and other interferences.

- F. Install piping and ductwork in furred spaces wherever possible. Run exposed piping and ductwork parallel to or at right angles to buildings walls.
- G. Keep horizontal lines as close to ceiling as practicable.
- H. Conform to ceiling heights established on architectural construction drawings.
- I. All equipment shall be installed to provide complete access for service, adjustment and filter replacement, as well as complete removal/replacement of unit from equipment room. Coordinate installation with all other trades to ensure that no piping, conduit, ductwork, structure, light fixtures, or other equipment obstruct complete access to the equipment. Coordinate access requirements for equipment actually provided with equipment manufacturer. Equipment installation shall not impede access to room. Equipment installed in violation of these requirements will be removed and re-installed at contractor's expense.

3.4 INTERFERENCES:

- A. Relocate or reroute existing pipe, wiring, or ducts as required to facilitate construction of finished work as planned. Restore surfaces, insulation, and finish to match condition of adjacent work.

3.5 CUTTING AND PATCHING:

- A. Assume costs and responsibility for cutting and patching required to complete the installation.

3.6 PAINTING AND FINISHING AND CLEANING:

- A. Provide touchup painting of prefinished mechanical products.
- B. Surfaces shall be left clean, debris shall be removed, and equipment shall be furnished in prime coat finish ready for finish coats.
 - 1. Piping, ductwork and equipment - Clean exterior of piping, ductwork and equipment, removing rust, plaster and dirt by wire brushing. Remove grease, oil, and similar materials by wiping with clean rags and suitable solvents.
 - 2. Motors, pumps and other items with factory finish - Remove grease and oil and leave surfaces clean and polished.
 - 3. Plumbing Fixtures - Clean and polish fixtures immediately prior to final inspection.
- C. Cleaning operations are supplemented by detailed instructions for specific systems.

3.7 OPTION TO RELOCATE OUTLETS AND RELATED DEVICES:

- A. Air supply outlets, return air inlets, exhaust air inlets, plumbing fixtures, and sprinkler heads may be relocated at the Owner's option to points within 10-feet of their indicated locations, at no additional cost to the Owner, provided the Contractor is notified prior to Shop Drawing preparation or roughing-in and fabrication.

- B. Only work which must be re-performed in this connection will be considered extra.

3.8 MECHANICAL SYSTEM VERIFICATION AND CALIBRATION:

- A. The mechanical contractor shall coordinate on-site system verification and calibration session(s) to document that the systems listed below are operating as intended. As a minimum, one 8-hour day shall be scheduled for the first session. Subsequent sessions shall be scheduled as needed until final verifications and calibration are complete.
1. The session shall follow complete installation and startup of all HVAC systems and the initial test and balance adjustments so that the integration effort will achieve the scheduled operation of each system.
- B. Session(s) shall be scheduled in advance and the General Contractor, Owner and Engineer shall be invited to attend.
- C. On-site attendance and participation in each session is mandatory for the following parties:
1. Equipment/system installing contractor.
 2. Equipment manufacturer's factory authorized representative(s).
 3. Temperature Controls Contractor.
 4. Test and Balance Contractor.
- D. Parts, tools and expertise:
1. The attending contractors and sub-contractors shall be equipped with typical components and materials to make corrections, adjustments and repairs of the installed equipment.
 2. The participants shall bring necessary tools and special equipment needed to make corrections or adjustments of the installed equipment and sub-systems where operation is being verified and/or calibrated.
 3. Personnel with the expertise to make full adjustments and/or programming changes shall be in attendance.
- E. Documentation of system verification and calibration:
1. Verify the system operation through full operating range is correct by testing and measurement of the controlled variables and response of equipment during automatic operation. Verify through complete operating sequences put into effect by simulation of seasonal conditions by temporary adjustment of system setpoints and necessary control points.
 2. The equipment/system Contractor shall prepare a record of the findings of the verification and calibration of each equipment item and/or system. The recorded findings shall identify the sequences verified and whether they were accepted or failed. Verification of system operation shall include:
 - a. Operation sequences.
 - b. Set points.
 - c. Calibration and coordination of installed sensors and instrumentation.

3. The Contractor shall identify items that do not operate as expected and those requiring further verification
- F. These requirements shall apply to the following equipment/systems:
1. New HVAC systems and equipment.
 2. Temperature controls.
- G. The Mechanical Contractor shall submit a report documenting the verification sessions and results for each piece of equipment affected. All deficiencies and deviations from the specified performance shall be documented.

END OF SECTION 23 01 00

SECTION 23 05 00 - HVAC MATERIALS AND METHODS**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Provide all pipe and fittings , piping specialties, valves, expansion joints, tanks, etc., as required for heating and air conditioning systems for the building.

1.2 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each piece of equipment, clearly indicating what features, options and accessories are being provided.
- B. See Section 23 01 00.

PART 2 - PRODUCTS**2.1 PIPING SYSTEM MATERIALS:**

- A. HVAC Water Systems shall be one of the following:
 - 1. ASTM A 53 black steel pipe, seamless or electric resistance welded. Sizes 12-inch and less shall be schedule 40.
 - 2. Type "L" ASTM B-88, hard-drawn copper tubing. Provide dielectric isolators at all connections between copper and ferrous piping.
 - 3. For pipe sizes 1-1/2 inches and smaller, Cross-linked polyethylene (PEX) may be used for the above water piping systems in lieu of steel or copper.
 - a. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency.
 - 1) Standard grade hydrostatic design and pressure ratings from Plastic Pipe Institute.
 - 2) Minimum Bend Radius (cold bending): No less than 6 times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
 - 3) Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876.
 - b. Fittings:
 - 1) Joints below grade shall be avoided if possible.

- 2) Fittings shall be of a type approved by the piping manufacturer for the application, and shall be supplied by piping manufacturer.
 - 3) Material: Fittings shall be suitable for direct burial in earth, and shall be manufactured from one of the following –
 - 4) Same material as piping.
 - 5) Polyalloy (ASTM 2359).
 - 6) Bronze (w/ stainless steel sleeve) (ASTM 877).
 - 7) Dezincified brass (ASTM 1807).
 - 8) Material Standard: Comply with ASTM F1960.
- c. Accessories
- 1) Bend supports designed for maintaining tight radius bends shall be supplied by the PEX tubing manufacturer.
 - 2) Tools required to install the piping fittings shall be supplied by the PEX tubing manufacturer.
 - 3) The tubing manufacturer will provide clips and/or PEX rails for supporting tubing runs.
- d. Warranty:
- 1) Warranty Period for PEX piping and fitting system shall be 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
- e. Acceptable Manufacturers – Mr. Pex, Uponor, Viega.
- B. Refrigerant Piping - shall be Type ACR copper. Elbows shall be long radius.
- C. All piping, fittings, valves and piping accessories shall be rated for a minimum working pressure of 125 psi (at maximum operating temperature), or 150 percent of the system operating pressure (at maximum operating temperature), whichever is the greater.

2.2 COPPER FITTINGS:

- A. Fittings for copper pipe shall be one of the following:
1. Recessed solder- joint type of either wrought copper or cast brass. Adapters for connection to threaded valves, fittings, meters and other equipment shall be cast brass. Recesses shall be smooth and correctly sized to provide proper clearance over the tubing.
 - a. Solder for water systems shall be composition 95/5 tin-antimony or Brigit. Flux shall be noncorrosive. The solder shall contain no lead.
 - b. Solder used for joining refrigerant piping shall be silver solder having a melting point of not less than 1120 F.
 2. Copper-tubing sized for grooved connections; wrought copper ASME B16.22 or cast bronze ASME B16.18. Victaulic Copper Connection.

3. Viega ProPress Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have SC (Smart Connect) feature design (leakage path). Smart Connect™ (SC Feature) In ProPress ½" to 4" dimensions the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
4. Grooved joint couplings assembly shall be securely held together by two trackhead, square or oval neck, steel bolts. Bolts and nuts shall be heat treated carbon steel and shall be in accordance with ASTM A-449 and A-183. Couplings shall be rigid Type, with housings cast with offsetting angle-pattern bolt pads to provide rigidity, at copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not allowed.).
 - a. 2-inch through 4-inch: "Installation-Ready" for direct stab installation without field disassembly, with Grade 'EHP' gasket, rated to 250° F. Victaulic Style 607 Quick-Vic.
 - b. 2-inch through 8-inch: Victaulic Style 606, with FlushSeal® gasket.

2.3 THREADED FITTINGS FOR WATER PIPE:

- A. Pipe fittings for threaded steel pipe, where neither the static nor the operating heads exceed 125 psi, shall conform to the following ANSI Standards:
 1. Cast Iron (threaded), 125 lb., ANSI B16.4, black or galvanized to correspond with pipe material.
 2. Malleable Iron (threaded), 150 lb., ANSI B16.3, black or galvanized to correspond with pipe material.
 3. Cast Iron (flange fittings), 125 lb., ANSI B16.1.
- B. In lieu of threaded cast iron fittings on ferrous pipe, Contractor may elect to use threaded ductile iron or steel fittings provided they conform to the pressure classification requirements for cast iron fittings.

2.4 UNIONS AND FLANGE FITTINGS:

- A. Unions smaller than 2-inch shall be in accordance with FS WW-U- 531 Type A, or B, as required to match adjacent piping. Union of 2-inch, 2 1/2-inch and 3-inch sizes shall be either cast iron or steel and flanges of 4-inch size and larger shall be forged steel. Forged steel flanges shall be 150 psi class slip-on or welding-neck flanges manufactured and marked in accordance with ANSI B16.5.
- B. Where space will permit bolting from either side of flanged joint, carbon steel machine bolts and nuts conforming to the requirements of ASTM A 307, Grade B, will be permitted for use with flanges up to and including 150-pound class. Where space does not permit installation of bolts, full threaded carbon steel studs and nuts equal in requirements to the machine bolts shall be used for flanges up to and including 150-pound class. For all flanges heavier than 150-pound class, alloy steel studs and nuts shall be used for bolting; studs shall conform to the requirements of ASTM A 193, Grade B 7, and nuts shall conform to the requirements of ASTM A1954, Grade 7.

- C. Flanges shall be spot-faced or back-faced parallel to the flange faces. Flanges heavier than 150-pound class shall be provided with grooved faces.
- D. Unions and flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)

2.5 WELDED FITTINGS:

- A. In lieu of threaded or flanged fittings, Contractor may, except at unions, fusion weld ferrous piping using welding rod of same material as pipe. Piping 2-inch size and larger shall be butt welded, and piping 1 1/2-inch size and smaller shall be connected with socket welding or threaded fittings.
- B. Factory made welding fittings shall be used for elbows and reducing fittings; mitered joint elbow and field made reducers shall not be used. Branch connections may be made with tees, factory made forged steel saddles, factory made shaped welding nipples, flared outlets, or shop fabricated butt welded branch having elliptical shaped nipple. Welding fittings shall be of the same wall thickness as the pipe in which they are installed.
- C. Welding fittings, outlets and flanges shall comply with the latest edition of the following standards and specifications:
 - 1. Butt Welding Fittings* - ANSI Standard B16.9*
 - 2. Socket Welding Fittings - ANSI Standard B16.11
 - 3. Wrought Carbon Steel - ASTM Specification A234
 - 4. Welded Flanges - ANSI Standard B16.5
 - 5. Forged Steel, General Purpose, for forged steel flanges, for pressures above 300 psi class* - ASTM Specification A105*Except for reducers, welding fittings need not comply with Section 6 of ANSI B16.9 provided they comply with all other applicable sections.

2.6 MECHANICAL PIPE COUPLINGS:

- A. Mechanical pipe couplings may be used-for connecting equipment to the piping system, headers, and distribution piping in lieu of unions or welded, flanged, or screwed pipe connections or soldered tube connections for water piping with temperatures from -30°F to 230°F (with EPDM gaskets).
- B. Couplings shall be self-centering and shall engage and lock in place the grooved or shouldered pipe and pipe fitting ends in a positive watertight couple. Fittings shall provide some degree of angular pipe deflection, contraction, and expansion where required.
- C. Coupling housing clamps shall consist of two-ductile iron castings complying with ASTM A-536. Housing clamps shall hold in place a composition water sealing gasket designed so that internal water pressure serves to increase the seal's watertightness.

- D. Couplings assembly shall be securely held together by two or more trackhead, square or oval neck, steel bolts. Bolts and nuts shall be heat treated carbon steel and shall be in accordance with ASTM A-449 and A-183. Couplings shall be
1. 2-inch through 12-inch:
 - a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
 - 1) 2-inch through 6-inch: "Installation-Ready" for direct stab installation without field disassembly, with Grade 'EHP' gasket, rated to 250° F. Victaulic Style 107 Quick-Vic.
 - 2) 2-inch through 12-inch: Victaulic Style 07 Zero-Flex
 - b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Style 77.
 - c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741.
 2. 14" through 24": Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
 - a. Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
 - b. Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.
 - c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style W741.
 3. Couplings shall be used according to the manufacturer's published temperature and pressure ranges.
- E. All pipe fittings connected to mechanical pipe couplings shall have groove or shouldered ends and shall be fabricated of ductile iron in accordance with ASTM A536; wrought steel in accordance with ASTM A234; or factory fabricated (and tested) from steel pipe conforming to ASTM A53.
- F. Before couplings are assembled, pipe ends, gasket lips, and outsides of gaskets shall be lightly coated with Victaulic Lubricant to facilitate installation.
1. Lubricant shall be supplied by the coupling manufacturer and shall be suitable for the gasket elastomer and system media.
- G. The pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. The dimensions should be according to the standard cut groove or roll groove specifications as recommended by manufacturer. Pipe grooving in the field shall be accomplished utilizing an automatic depth stop grooving tool. Coupling manufacturer shall provide Pi tapes, 'Go/No-Go' gauges, etc. to verify groove dimensional requirements are in compliance with standards.

- H. Pipe and fitting assembly requires that all nuts shall be tightened to assure firm and visual metal contact of the coupling pads.
 - 1. Couplings that require exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.
- I. All grooved products shall be of the same manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- J. Entire coupling installation shall be in accordance with the latest published manufacturer's recommendations.
- K. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)
- L. Acceptable Manufacturers - Victaulic.

2.7 SLEEVES AND PLATES:

- A. See Section 230100.

2.8 PIPE HANGERS AND SUPPORTS:

- A. See Section 230100.

2.9 VALVES, GENERAL:

- A. Valves in water service shall be of the ball type, or butterfly type.
- B. Valves in water system pump discharge connections shall be of the ball or butterfly type.
- C. Valves shall have a working pressure of 125 psi or 150 percent of the system operating pressure, whichever is the greater.
- D. Provide extended neck valves where installed in insulated piping.
- E. Ball and Butterfly Valves: All nonmetallic components and elastomers shall be suitable for 200°F. minimum continuous operating temperature, or not less than 50°F. above the operating temperature of the system, whichever is higher. All mating surfaces of closure faces shall be of bronze or Type 304 316, 17-

4PH stainless steel, or elastomer, approved for the particular service, and materials must be compatible to prevent poisoning of contact surfaces of different materials (electrolytic action). Each valve shall be provided with handle or wheel which shall be secured to the stem or chained to the valve body. Ball and butterfly valves shall be designed for dead end service and bubble tight shutoff.

1. Ball valves shall be used on lines 2-inches and smaller.
 - a. Valves shall have bronze body, stainless steel ball and teflon seat with flanged or threaded ends, and shall be Style 1 (valve serviceable without disturbing piping connection), except that valves with bolt through or flanged bodies may be furnished. Valves 1-inch size and smaller, used exclusively for balancing, may be forged brass, Styles 2 or 3. Valves used in runouts to room heating and cooling units may have sweated ends or compression type fittings.
 - b. Valves shall have forged brass body, chrome-plated brass ball and stem, TFE seat, fluoroelastomer seals, with Vic-Press 304™ ends. Valves may be used for balancing and shutoff. Valves shall be rated to 300 psig CWP. Victaulic Series 589.
 - c. Grooved end valves for sizes through 6" shall have ductile iron body, chrome-plated steel or fully stainless steel ball and stem, TFE seats, fluoroelastomer seals, with lever handle or gear operator. Victaulic Series 726.
 2. Butterfly valves may be used on lines larger than 2-inches. Valves shall be resilient seated type, provide tight closure, and shall be structurally designed to provide closure against the system operating pressure. Valve shall have ductile iron or cast iron body, stainless steel disc or coated ductile iron disc, stainless steel stem, reinforced teflon bushings and EPDM pressure responsive or disc mounted seat. (Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.) Shaft seals shall be of the "O" ring type. Stems, discs, and operators shall be designed for a water velocity of 16 feet per second through the nominal pipe area with no downstream obstructions. Bodies shall be flanged or wafer type. Valve flanges shall be of the same class as required for the lines in which they are installed. Valve 8-inches and large shall be provided with enclosed worm gear or traveling nut type operators equipped with lubricating fittings, or be permanently lubricated. Valves which serve to isolate systems to permit removal of equipment shall have bodies with integral flanges, or full lugs drilled and tapped, to hold valve in place when piping or equipment is removed. Valves installed with mechanical couplings shall have grooved or shouldered ends suitable for the approved couplings. Valves in insulated line shall have extended necks to accommodate the thermal insulation covering. Victaulic MasterSeal (sizes through 12-inches or AGS-Vic300 (sizes 14-inches through 24-inches).
 3. Butterfly valves for grooved end copper-tubing systems 2 1/2-inches through 6-inches shall have cast bronze body conforming to ASTM B584, elastomer coated ductile iron disc with integrally cast stem, nickel plated 416 stainless steel upper and lower stem nuts, and elastomer seals. Ends shall be grooved, manufactured to copper-tube dimensions. Valves shall be lever or gear operated. Victaulic Style 608.
- F. Nonslamming Check Valves: Nonslamming or silent check valves shall be of the fully guided conical spring, torsion spring actuated type or cone and diaphragm type. Bodies shall be grooved end, flanged or wafer type and shall be constructed of ductile or malleable iron, stainless steel or cast bronze in accordance with the following specifications:
1. Ductile Iron: ASTM Specification A536
 2. Malleable Iron: ASTM Specification A-47
 3. Cast Steel: ASTM Specification A-216, Class WCB.

4. Cast Bronze: ASTM Specification B-61.
- G. Seats, discs and springs shall be constructed of 18-8 and/or 300 series stainless steel, or bronze complying with ASTM B-62. Seats may be elastomers, suitable for 230°F minimum continuous operation temperature, or not less than 50°F, above the operating temperature of the systems, whichever is higher. All mating surfaces of the closure faces shall be of bronze, welded-in nickel, or Type 304, 315 or 17-PH stainless steel, or elastomer, approved for the particular service, and materials must be compatible to prevent electrolytic action.-
1. Nonslamming check valves shall provide bubble tight shutoff when handling water up to 230°F., and shall be designed to prevent rubbing of seat material when opening and closing. Poppet type valves shall have conical springs.
 2. For grooved end piping systems, Victaulic Series 716 and Series W715 shall be used.
- H. Acceptable Manufacturers - DeZurik, Milwaukee, Nibco, and Victaulic, Watts.

2.10 WATER FLOW BALANCING PROVISIONS:

- A. Each space cooling or heating device (coil, air unit, unit heater, fan-coil unit, baseboard radiation, etc.) shall be installed with provisions for measuring entering and leaving temperatures and pressure differential. Provide flow measuring devices where indicated.
1. Every device shall have a ball or butterfly valve in supply line for service and a ball or butterfly valve with memory stop in the return line for balancing and service.
 2. Every device shall have a P/T test plug in the supply and return line for direct insertion of a pressure gauge or thermometer.
 3. Where 3-way mixing valve control is required, a P/T test plug shall be installed between the coil outlet and valve inlet. A P/T test plug shall be installed in the line on the outlet side of the valve. A ball or butterfly valve with memory stop shall be installed in the bypass line to the valve inlet.
 4. P/T test plugs shall be located as close as possible to equipment connections.
- B. Every new blower coil unit and other equipment where indicated on plans, shall have a calibrated flow control device equivalent to the Bell & Gossett Circuit Setter Plus, installed in the return line.

2.11 SAFETY AND RELIEF VALVES:

- A. Water Relief Valves: Provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, constructed in accordance with ASME Boiler and Pressure Vessel Code.
1. Pressure Relief Valves: Construct of bronze body, metallic disc, metal seat, with nonmechanically guided stem. Set valve to relieve at 10 psi above operating pressure, or as indicated on Drawings.
 2. Acceptable Manufacturers - Amtrol, Inc., Bell & Gossett, ITT, Sarco Co., Watts Regulator Co.

2.12 BALANCING TAPS (TEST PLUGS):

- A. See Section 230100.

2.13 DIELECTRIC ISOLATORS:

- A. Dielectric isolators shall be so designed that no nonferrous materials come in contact with ferrous materials. These materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions of insulating gaskets and bolt sleeves and washers for standard flanged connection. Where it will not be necessary to disconnect these piping systems, the connections may be made by the use of Schedule 80 CPVC nipples, CPVC nylon or Teflon bushings. Insulating units shall be selected for pressures and temperatures to be encountered.
- B. Acceptable Manufacturers - EPCO, Crane, F.M. Maloney, Universal, Walter Vallett.

2.14 AIR VENTS:

- A. Automatic air vents shall be direct acting or compound lever action cast iron body, stainless steel float, bronze linkage, and noncorrosive seat.
- B. Manual air vents shall be lever handle brass cocks.
- C. Acceptable Manufacturers - APCO, Armstrong, Bell & Gossett, Clark, Golden Anderson, Hoffman, Sarco.

2.15 STRAINERS:

- A. Provide strainers-
 1. At inlet to automatic control valves with 0.020- inch mesh screen.
 2. At pump suction with 0.25-inch mesh screen.
 3. Of same or higher temperature and pressure rating as piping system in which installed, and compatible connections.
 4. With stainless steel or monel screens unless specified otherwise.
 5. With bronze bodies and screen in copper piping.
 6. With cast semisteel, cast steel, forged steel or cast iron body as required for the pressure rating of the system unless specified otherwise.
- B. Provide Y pattern strainers with screwed or bolted cap except as otherwise indicated.

PART 3 - EXECUTION**3.1 EQUIPMENT INSTALLATION:**

- A. Installation Compliance. Install all equipment and system components in accordance with manufacturer's instructions and as shown on the drawings.

3.2 AIR VENTS:

- A. Install automatic air vents on coil systems and at high points in pipes of appropriate pressure ratings for point of installation, but in no case less than 150 psi.
- B. Extend vent pipes from automatic vents from vent point to drain at visible and accessible location.

3.3 UNIONS:

- A. Provide a union connection at each piping connection to each item of equipment.
- B. Unions on threaded piping systems shall be ground joint malleable iron, with finish to match piping.
- C. Unions on piping systems 2 1/2-inch and large shall be companion flange design complete with gaskets, bolts and nuts.
- D. Unions shall be of appropriate pressure rating for the point of installation, but in no case less than 150 psi.

3.4 JOINING PIPE:

- A. Furnish labor, materials, and supplies for the proper joining of each piping system.
- B. Welding of piping systems shall conform to American Standard B31.1 and American Welding Society Standard B3-0.
- C. Copper Water Piping, Soldered - Cut ends square, ream and polish pipe surface, polish inside of socket fitting. Tubing ends and fitting recesses shall be thoroughly cleaned. Apply flux to pipe into fitting, align, apply heat and solder, sweat together. Solder shall penetrate fully and shall fill the joint completely.
- D. Copper, Grooved – Copper tubing may be roll grooved at copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) The pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. The dimensions shall be according to the roll groove specifications as recommended by the manufacturer. Pipe grooving in the field shall be accomplished utilizing an automatic depth stop grooving tool with roll sets for copper tubing. Pipe and fitting assembly requires that all nuts shall be tightened to

assure firm metal contact of the coupling pads. Manufacturer's field service engineer/representative shall provide on site training to insure installers adhere to manufacturer's installation instruction. (A distributor's representative shall not be considered qualified to conduct the training.) All grooved products shall be manufactured by Victaulic.

- E. Steel, Threaded - Cut square, thread with tapered thread, use adequate quantity of cutting oil, ream end of pipe, apply thread compound, insert into fitting and makeup.
- F. Steel, Welded - Cut square, ream, set fitting and tack, check for squareness, weld electrically, use coated electrodes compatible with pipe, chip welds, brush clean. Seal weld slip -on flanges internally, as well as fillet weld externally.
- G. Steel, Grooved - Grooved black iron or steel pipe may be cut or hydraulically roll grooved; however, galvanized iron pipe shall only be hydraulically grooved. The pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. The dimensions shall be according to the standard cut groove or roll groove specifications as recommended by the manufacturer. Pipe grooving in the field shall be accomplished utilizing an automatic depth stop grooving tool. Pipe and fitting assembly requires that all nuts shall be tightened to assure firm metal contact of the coupling pads. Manufacturer's field service engineer/representative shall provide on site training to insure installers adhere to manufacturer's installation instruction. (A distributor's representative shall not be considered qualified to conduct the training.) All grooved products shall be manufactured by Victaulic.
- H. Copper and Stainless Steel Press-Fit Systems (Viega ProPress or Victaulic Vic-Press 304™): Install in accordance with manufacturer's recommendations. Pipe shall be approved by manufacturer for use with fittings. Piping shall be square cut, properly deburred, and cleaned. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
- I. Copper Refrigerant Piping - Cut ends square, ream and polish pipe surface, polish inside of socket fitting. Tubing ends and fitting recesses shall be thoroughly cleaned. Apply flux to pipe into fitting, align, apply heat and solder, sweat together. Solder shall penetrate fully and shall fill the joint completely.
 - 1. Flow dry nitrogen inside pipe while soldering refrigerant pipe.
- J. PEX Piping – Piping joints shall be made in accordance with manufacturer's instructions.

3.5 PIPING INSTALLATION:

- A. Above Grade - Run level and as high as possible. Install hangers per schedule. Install to allow for expansion and contraction. Anchor where shown and where required. Allow access to equipment, for removal of heads, for servicing of the device. Support piping from beams, joists, or other structural supports.
- B. Do not route piping above electrical distribution equipment, per National Electric Code.

- C. Closed Circulating Water Systems - Run level, square to building, as high as possible. Install hangers per schedule. Vent high points, drain low points. Install valves on each side of each piece of equipment. Install valves at strainers. Provide valves and flanges to allow removal of heads and servicing of equipment without draining piping system. Install cutoff and drains to allow drainage of all pipes subject to freezing. Set control valves.
- D. Pipe size changes in horizontal pipes containing liquid shall be made with eccentric reducers where necessary to allow complete system drainage.
- E. Where piping must be run exposed to view, obtain prior approval of routing from the Architect. Coordinate with the Electrical Contractor so that exposed conduit and piping are grouped together.
- F. Copper Piping Installation:
- a. Isolate copper pipe from concrete at all locations where piping penetrates concrete or masonry construction.
- G. PEX Piping Installation:
1. Do not proceed with installation of the PEX potable water system until unacceptable conditions are corrected.
 2. Install PEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
 3. Joints below grade shall be limited to those required for tees and connection to valves at connections to buildings.
 4. Do not solder within 18 inches of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
 5. Do not expose PEX tubing to direct sunlight for more than 30 days.
 6. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
 7. Protect PEX tubing with sleeves where abrasion may occur.
 8. Use tubing manufacturer supplied bend supports where bends are less than six times the outside pipe diameter.
 9. Minimum horizontal supports are to be installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
 10. Pressurize tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi (173 kPa) above normal working pressure of the system.
 11. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32 degrees F (0 degrees C).
 12. Field Quality Control:
 - a. Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and one site visit for inspection of product installation in accordance with manufacturer's instructions.

3.6 PIPE HANGERS AND SUPPORTS:

- A. See Section 230100.

3.7 COMPLETION:

- A. Complete entire piping systems. Properly support the system, clean the interior surfaces of the pipe, leave strainer baskets clean, all system filled and free from air, and ready for operation testing.

3.8 DIELECTRIC ISOLATION:

- A. Wherever copper, brass or bronze systems or equipment are connected to steel or iron piping systems or equipment, this connection shall be made with dielectric isolators.
- B. Arrange pipe hangers and supports such that electrical continuity is essentially nonexistent between ferrous and nonferrous piping, structure, materials, or equipment.

3.9 COMPLETE SYSTEMS:

- A. Install devices required in the piping system regardless of the responsibility of supplying them. Specifically, install automatic control valves, flow switches, pressure taps, thermometer wells, orifice flanges and miscellaneous devices.

3.10 VALVES:

- A. Provide shut off valves at the inlet and outlet of each piece or equipment, ahead of control valves, and as shown. Provide drain valves at low points to allow complete drainage of each closed pressure piping system. Provide vent valves at high points to allow complete venting of each closed pressure piping system. Install valves with stems horizontal or inclined above horizontal. Locate manual valves, control valves, and accessories in accessible areas to provide ready access for operation and maintenance.

3.11 TESTING PIPING SYSTEMS:

- A. See Section 23 99 00.

END OF SECTION 23 05 00

SECTION 23 25 00 - INSULATION (MECHANICAL)

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Thermal insulation of piping systems, plumbing, casings and equipment installed under other Sections of these Specifications.

1.2 REFERENCE STANDARDS:

- A. ASHRAE 90A - 1980, Section 5.
- B. NFPA 90A, Air Conditioning and Ventilation Systems.
- C. UL Guide No. V.8.15 (Jackets, Adhesives and Sealers).
- D. SMACNA, Sheet Metal and Air Conditioning Contractors National Association.

1.3 SUBMITTALS:

- A. Submit manufacturer's product data on insulation materials, jackets, accessory materials, adhesives, tapes, etc. Submit a schedule for each class of insulation specified, indicating product, thickness, quantities, sizes, installation details, and surfaces to which each class is to be applied.
- B. See Section 23 01 00.

1.4 QUALIFICATIONS:

- A. Insulation shall be installed by a firm whose principal business is the application and installation of thermal insulating material on piping and duct systems. Materials shall be by recognized manufacturers and shall be installed by skilled mechanics in accordance with manufacturer's standard published instructions except as otherwise specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Accessory Materials - Childers, Fosters, P.K. Insulation, Vimasco.

- B. Insulation Material - Armstrong Cork, CertainTeed, Delta Systems, Inc., E.O. Wood, Fibrex, Knauf Fiber Glass, Manville, Owens-Corning Fiberglass, Partek.

2.2 ACCESSORY MATERIALS:

- A. Hanger Adhesive - Foster 55, red-brown, or approved equivalent.
- B. Insulating Cement - P.K. Insulation Quick Coat or One Coat, or approved equivalent.
- C. Metal Bands - 1/2-inch wide, 0.20-inch thick aluminum.
- D. Flexible Cellular Insulation Adhesive - Armstrong 520 or Foster 82-40, or approved equivalent.
- E. Glass Fabric Cloth - 8 ounce per square yard sized woven cloth.
- F. Glass Fabric Cloth Jacket Sealer, UL listed lagging adhesive, white - Foster 30-36, or Childers CP-50 pigmented, or approved equivalent.
- G. Vapor Barrier Mastic, White - Foster 30-35 or Childers CP-30, or approved equivalent.
- H. Weather Barrier Mastic, White - Foster 35-00 or Childers CP-10, or approved equivalent UL classified outdoor grade elastomeric vinyl mastic.
- I. Fiberglass Insulation Bonding Adhesive, Amber-Foster 85-15 or Childers CP-82, or approved equivalent.
- J. Mechanical Surface Fasteners – Benjamin Foster, Duro Dyne, Manville.

2.3 INSULATION JACKETS:

- A. ASJ Jacket - All Service Jacket - Vinyl coated and embossed vapor barrier laminate of 40 pcf white kraft, aluminum foil, and flame snuffing adhesive, reinforced with glass fibers, 0.05 permeability rating.
- B. PVC Jacket - 20 mil minimum thickness polyvinyl chloride pipe and fitting jacketing, UV resistant with maximum of 25/50 flame/smoke spread rating per ASTM 84. Install with waterproof solvent welding contact adhesive, vapor barrier mastic adhesive, and PVC tape. Do not staple or penetrate vapor barrier.
 - 1. Equivalent to Johns Manville Zeston.

2.4 TYPE FDL INSULATION:

- A. Fiberglass Duct Liner, blanket material in roll form, meeting the requirements of ASTM C1071 and the additional following requirements.

1. Have a potential heat value not exceeding 3500 btu/lb when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.
2. Maximum rated velocity not less than 5000 FPM when tested in accordance with ASTM C 1071.
3. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C 1138, G 21 and G22.
4. Have a maximum thermal conductivity(k-value), at 75°F mean temperature, of .24 Btu.●in/hr.●sq.ft.●°F.
5. Sound absorption coefficients and NRC shall meet or exceed the following when tested in accordance with ASTM C 423 using an “A” mounting.

Thickness	Type	Absorption Coefficients @ Octave Band Frequencies (Hz)							NRC
		125	250	500	1000	2000	4000		
1/2"	200	.05	.15	.35	.61	.75	.88	.45	
1"	150	.06	.27	.66	.87	.98	.99	.70	
1-1/2"	150	.18	.53	.97	1.06	1.06	.90	.90	
2"	150	.24	.74	1.12	1.11	1.07	1.08	1.00	

- B. Fiberglass Duct Liner shall be equivalent to Certainteed Tough Gard R.

2.5 TYPE FDB INSULATION:

- A. Foil Faced Fiberglass Duct Wrap Blanket, UL labeled, reinforced foil kraft vapor barrier jacket, 0.30 K factor 75°F, mechanically fastened to duct using insulation pins welded to duct. Insulation pins shall not penetrate to the inside of ducts.
- B. Conforming to FS HH-I-558B, Form B, Type 1, Class 6, ASTM C- 553.

2.6 TYPE FPC INSULATION:

- A. Fiberglass Pipe Covering, 0.23 K factor at 75 F., molded in cylindrical form to fit pipe snugly, sectional one-piece construction, with factory applied flame resistant vapor barrier jacket with double self-sealing flap.
- B. Conforming to FS HH-I-558B Form D, Type 3, Class 12 and ASTM C547.

2.7 TYPE PFP INSULATION:

- A. Plastic Flexible Pipe Covering - Flexible closed cell fire resistant foamed plastic material, 0.10 water vapor permeability per ASTM E96 procedure A, , 0.27 K factor at 75°F per ASTM C177 or C518, 5% water absorption by weight per ASTM D1056, molded in cylindrical form to fit pipe snugly. The insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E84-91A. The insulation shall be equivalent to AP Armaflex.

2.8 PIPE INSULATION SADDLES:

- A. Provide 180 degree, 16 gauge galvanized steel protection saddle, 12 inches long, at individual pipe hanger support locations.
- B. Provide 360 degree, 16 gauge galvanized steel protection saddle, 12 inches long, at each pipe which is clamped to a trapeze hanger.

2.9 HANGER SHIELDS:

- A. Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 degree, 24 gage minimum sheet metal hanger shield with insert of high density, 100 psi, waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 1-inch spacing between sleeve and insulation shield. Pack annular space between sleeve and shield as specified under "Fire-Stopping" in the Section 23 01 00. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 1-inch beyond penetrated surface and escutcheon.

2.10 ADHESIVES, MASTICS AND SEALANTS:

- A. Utilize materials recommended by insulation manufacturer for the application.
- B. 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.

2.11 PIPE INSULATION FITTINGS:

- A. Fittings shall be premolded of the same material and thickness as the pipe covering and provided with a matching vaporproof barrier, or build up the fittings from segments of pipe insulation or fibrous glass blanket to the proper thickness and then finish with fire retardant tape and vaporproof barrier. Fittings so covered shall be finished with a fire retardant covering to form a smooth, neat appearance similar to that on the straight length of pipe.
- B. Valves, strainers, expansion tanks, and similar appurtenances shall be insulated as specified for fittings except that valve bonnets and strainer cleanouts need not be insulated.
- C. One-piece premolded PVC fitting and valve covers may be provided in lieu of fitting jacketing specified.
- D. Where Type ASJ jacketing is specified, one-piece premolded PVC fitting and valve covers may be provided in lieu of fitting jacketing specified.

PART 3 - EXECUTION

3.1 VAPOR SEALED PIPE INSULATION APPLICATION:

- A. Apply insulation only to clean dry pipe after it has been thoroughly tested. Each section of insulation shall be firmly butted together with the end surface of a section of covering having the entire surface buttered with vapor barrier cement and the adjacent end surface of the next section of covering pushed tight to this mastic and vapor sealed.
- B. In areas subject to physical abuse, such as gymnasiums, and when recommended by insulation manufacturer, apply outwardly clinched staples, minimum three per length of insulation. Seal all staple locations with white vapor barrier cement.
- C. At points where pipe hangers occur, insulation damage shall be prevented.

3.2 FLEXIBLE FOAMED PLASTIC PIPE INSULATION APPLICATION:

- A. Insulation shall be cylindrical without longitudinal joint and slipped over the pipe prior to erection wherever possible. Seal circumferential butt joints with flexible tubing adhesive. Where slip-on technique is not possible, insulation shall be slit longitudinally, applied to pipe, and longitudinal and circumferential joints sealed with flexible tubing adhesive.

3.3 DOMESTIC COLD AND HOT WATER PIPING:

- A. Insulate in their entirety except do not insulate 1/2-inch and smaller branches in pipe chases serving single fixtures or horizontal stubouts directly to fixtures from pipe chases or chrome plated pipe.
 - 1. Exception – Insulate PEX water piping routed in exterior wall, on room side of insulation.
- B. Insulate hot and cold water and waste piping beneath handicapped sinks. Provide manufactured piping covers consisting of flexible vinyl insulation with white finish and access to piping, equivalent to Handi Lav-Guard manufactured by Truebro, Inc.
- C. Utilize PFP insulation for hot water below grade, FPC insulation for cold and hot water above grade.

3.4 COLD DRAIN PIPING:

- A. Insulate condensate drain piping completely from the unit drain pan to the point of connection to the sanitary waste system.
 - 1. Exception - Condensate drain piping inside of mechanical rooms does not require insulation.
- B. Cold Condensate or Electric Water Cooler Drains – Insulate sanitary waste above grade from drain receiving cold liquid to point of connection to vertical stack or sanitary waste affording dilution adequate to preclude condensation on uninsulated pipe, including "P" trap and vertical piping down to the first elbow.

- C. Rain Water Drain Piping - Insulate only those portions of the downspouts above grade which run horizontally, including the elbow turned down and the elbow turned up, to and including portions of the roof drains below the roof and vertical piping down through the first elbow.

3.5 DUCT INSULATION:

- A. Insulate ductwork as scheduled in this Section. Material shall be as specified for each insulation class.
- B. Provide access door insulation so that doors can be opened without damaging insulation.
- C. Do not insulate preinsulated ductwork or flexible runouts.

3.6 DUCT LINER:

- A. Fabrication and installation shall conform to manufacturer's recommendations and to the requirements of the latest edition of the North American Insulation Manufacturers Association's *Fibrous Glass Duct Liner Standard*, or of the Sheet Metal and Air Conditioning Contractors National Association *HVAC Duct Construction Standards - Metal and Flexible*) or the manufactures recommendations.
- B. All portions of duct designated to receive duct liner shall be completely covered with duct liner. All joints shall be neatly butted and there shall be no interruptions or gaps. Duct liner shall be installed with the black surface treatment exposed to the air stream.
- C. Duct liner shall be adhered to the sheet metal with 90% (minimum) coverage of adhesive complying with the requirements of ASTM C 916.
- D. All transverse edges that are not to receive sheet metal nosing shall be coated. Longitudinal joints shall occur at the corners of ducts. If duct size and standard duct liner product dimensions make exposed longitudinal joints necessary, such joints shall be coated with adhesive designated for duct liner application and which meets the requirements of ASTM C 916. Such joints shall be additionally secured with mechanical fasteners in accordance with NAIMA FGDLS, or SMACNA HVAC DCS as if they were transverse joints.
- E. Duct liner shall be additionally secured with mechanical fasteners complying with the requirements NAIMA FGDLS or SMACNA HVAC DCS and of the correct type for the duct liner being installed. Fasteners shall be weld-secured, shall be installed perpendicular to the duct surface and shall penetrate to the outside of ducts.. Mechanical fasteners shall not compress the insulation more than 1/8" (3 mm) based on nominal insulation thickness. Fastener spacing with respect to interior duct dimensions shall be in accordance with NAIMA FGDLS or SMACNA HVAC DCS. Fastener heads or washers shall have a minimum area of 0.75 in² (484 mm²), with beveled or cupped edges to prevent their cutting into the duct liner.
- F. Where air velocities exceed 4000 fpm (20.3 m/sec), metal nosing (either channel or "zee" profile) shall be installed on upstream edges of liner duct sections.

- G. Metal nosing shall be securely installed over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct.
- H. Duct liner in roll form shall be folded and compressed in the corners of rectangular duct sections, or shall be cut and fit to assure a lapped, compressed corner joint
- I. Duct liner in sheet form shall be cut and fit to assure tight, over-lapped corner joints. Top pieces of liner shall be supported at the edges by the side pieces
- J. Any damage to the air stream surface must be repaired by coating the damaged area with adhesive or coating designed for duct liner application. Adhesive or coating shall meet requirements of ASTM C916
- K. Field Quality Control
 - 1. Upon completion of installation of lined duct and before HVAC system start-up, visually inspect the ductwork and verify that duct liner has been correctly installed. Confirm that the duct system is free from construction debris.
 - 2. After the lined duct system is completely installed and ready for service, conduct a final inspection of the entire system. This inspection should include, at minimum, the following steps:
 - 3. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris.
 - 4. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.
 - 5. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork.
 - 6. Turn the HVAC system on and allow it to run until steady state operation is reached.
 - 7. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
- L. Protection
 - 1. Contractor' employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.
 - 2. The contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.7 DUCT INSULATION SCHEDULE:

Note: All ductwork shall be either insulated or lined unless specifically noted otherwise below or on plans.

	TYPE	THICKNESS (Inches)
A. Rectangular Supply Duct	FDL	½

B.	Rectangular Return Duct	FDL	½
C.	Round Supply Duct	FDB	1 ½
D.	Rectangular Exhaust Duct	FDL	½
E.	Round Exhaust Duct	---	---

3.8 PIPE INSULATION SCHEDULE:

	PIPE SIZE (Inches)	INSULATION TYPE	THICKNESS (Inches)	JACKET TYPE	
A.	Domestic cold and hot water (PEX) in exterior walls, on room side of insulation	All	PFP	1	---
B.	Domestic cold water above grade	All	FPC	½	ASJ*
C.	Domestic cold water below grade	All	---	---	---
D.	Domestic hot water & recirculating above grade	All	FPC	1	ASJ*
E.	Domestic hot water & recirculating below grade	All	PFP	1	---
F.	Condensate drain piping	All	FPC	1	---
G.	Heating Water Supply and Return	Under 1 1 & Over	FPC FPC	½ 1	ASJ ASJ
H.	Refrigerant suction piping indoors	Under 1 1 and over	PFP PFP	½ 1	--- ---
I.	Refrigerant suction piping outdoors	Under 1 1 and over	PFP PFP	½ 1	PVC PVC

*Apply PVC jacket to all insulated piping installed outdoors and exposed in rooms, freezers and coolers; exception - mechanical rooms.

END OF SECTION 23 25 00

SECTION 23 69 00- PUMPS**PART 1 - GENERAL****1.1 WORK INCLUDED**

- A. Provide pumps as herein specified, shown on Drawings or scheduled for use with HVAC systems and equipment specified in other Sections.
- B. Unless otherwise specified, pumps shall include motors, starters, controls, drive train, base or mountings, and accessories required to function properly and safely for the service intended.

1.2 SUBMITTALS

- A. Submit complete printed catalog and descriptive data for each major piece of equipment, clearly indicating exactly what features, options and accessories are being provided. Include vibration isolating equipment.
- B. See Section 23 0100.

PART 2 - PRODUCTS**2.1 PUMPS (GENERAL)**

- A. Provide as scheduled.
 - 1. Shop drawing data for each pump shall include total head, efficiency, brake horsepower, and pump curves.
- B. The pump shall be selected to operate on the ascending portion of efficiency curve, be non-overloading and such that the impellers are not more than 90% of their maximum size. Shop drawing data for each pump shall include total head, efficiency, brake horsepower, and pump curves.
- C. All pumps shall be provided with premium efficiency motors.
 - 1. See Section 23 0100.

2.2 END SUCTION, BASE MOUNTED CENTRIFUGAL PUMP:

- A. The pumps shall be long coupled, base mounted, single stage, end suction, vertical split case design, in cast iron stainless steel fitted, specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure or optional operations at up to 250°F and 250 PSIG working pressures. Working pressures shall not be de-rated at temperatures up to 250F. The pump internals shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.

- B. The pumps shall be composed of three separable components a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupling.
- C. A bearing assembly shall support the shaft via two heavy-duty regreaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be regreaseable without removal of the bearings from the bearing assembly. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
- D. The bearing assembly shall have a solid SAE1144 steel shaft. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.
- E. Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines. Seal assembly shall have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- F. Bearing assembly shaft shall connect to a stainless steel impeller. Impeller shall be both hydraulically and dynamically balanced to ANSI/HI 9.6.4-2009, balance grade G6.3 and secured by a stainless steel locking cap screw or nut.
- G. Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.
- H. A center drop-out type coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. Coupling shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections. On variable speed applications the coupling sleeve should be constructed of an neoprene material to maximize performance life.
- I. An ANSI and OSHA rated coupling guard shall shield the coupling during operation. Coupling guard shall be dual rated ANSI B15.1 and OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling. No more than .25 inches of either rotating assembly shall be visible beyond the coupling guard.
- J. Pump volute shall be of a cast iron design for heating systems with integrally cast pedestal volute support, rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports.
- K. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation by the manufacturer's representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to standards outlined in EISA 2007.
- L. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.8.2.1-2009 for grouted Horizontal Baseplate Design standards.
- M. Pump shall be of a maintainable design and, for ease of maintenance, should use machine fit parts and not press fit components.

- N. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2009 for recommended acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2009 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
- O. Pump manufacturer shall be ISO-9001 certified.
- P. Each pump shall be hydrostatically tested 1.5 times the maximum rated working pressure and name-plated before shipment.
- Q. Pump shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
- R. Acceptable Manufacturers - Armstrong, Aurora, Bell & Gossett, Taco.

PART 3 - EXECUTION

3.1 MANUFACTURER'S DIRECTIONS

- A. Install equipment in strict accordance with manufacturer's recommendations and requirements of other Sections.

END OF SECTION 23 69 00

SECTION 23 80 00 - HVAC EQUIPMENT - AIR SIDE**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install air-side heating, ventilating and air handling equipment of all types employed in the Project.

1.2 REFRIGERANT AND OIL:

- A. Furnish an adequate supply of refrigerant and oil, and maintain refrigerant and oil in the system in proper quantities for one year from the date of acceptance by the Owner.
- B. At the end of one year's operation, an inspection of each system shall be made to determine the refrigerant charge. At that time the refrigerant charge shall be brought up to full charge, and the source of leakage necessitating addition of refrigerant shall be found and corrected.
- C. Replacement of refrigerant lost or contaminated during the one year period from the date of acceptance to the date of inspection shall be provided without additional charge for both labor and material.

1.3 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment. Include:
 - 1. Equipment, piping and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections
 - 2. Piping, valves and fittings shipped loose showing final location in assembly
 - 3. Control equipment shipped loose, showing final location in assembly
 - 4. Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads
 - 5. Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers
 - 6. Fan performance curves
 - 7. Type of refrigerant used
 - 8. Plan view, front view end view, back view and curb detail with dimensions
 - 9. Quality Assurance:
 - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties
 - b. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements
 - c. Manufacturer's Instructions: Manufacturer's installation instructions
 - 10. Manufacturer's Field Reports: Manufacturer's field reports specified herein
 - 11. Closeout Submittals: Submit the following:

- a. Warranty: Warranty documents specified herein
 - b. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Closeout Submittals (Maintenance Data and Operation Data) Section. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance. Include names and addresses of spare part suppliers
 - c. Provide brief description of unit, with details of function, operation, control and component service
 - d. Provide equipment inspection report and equipment operation test report
- B. See Section 23 01 00.

PART 2 - PRODUCTS:

2.1 SMALL AIR HANDLING UNITS (UP TO 4,000 CFM) W/ SPLIT D-X COOLING:

- A. General Unit Description – Provide air handling units as scheduled. Units shall be completely factory assembled, tested and shipped as one piece. All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums. Units shall be ETL listed and also in compliance with UL/ANSI Standard 1995 (USA) CSA C22.2#236 (CA) and be certified as complying with the latest edition of AHRI Standard 430.
- B. Cabinet Construction -
1. All cabinet walls and access doors shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
 3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel and prevents exterior condensation on the panel.
 4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 5. Access to filters, coils, supply fans and electrical and controls components shall be through hinged access doors. Stainless steel hinges shall be included on the doors.
 6. Access doors shall be flush mounted to cabinetry, with stainless steel removable hinges and quarter-turn, zinc cast lockable handles.
 7. Units with cooling coils shall include a 304 stainless steel sloped drain pan. Drain pan connection shall be on the either side of the unit.
 8. Cooling coils shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.
 9. Unit shall include a 5-inch forklift base.
- C. Coils -
1. Evaporator Coil
 - a. Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes

with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

- b. Coil shall two circuits and interlaced circuitry.
 - c. Coil shall be 4 row and 14 fins per inch.
 - d. Coil shall be hydrogen or helium leak tested.
 - e. Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.
 - f. Coil shall have right hand external piping connections. Liquid and suction connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
1. Hot Water Heating Coil
 - a. Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
 - b. Coil shall be designed and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - c. Coil shall have single serpentine circuitry, 2 row and 12 fins per inch.
 - d. Coil shall have right hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
 - e. Control valves shall be field supplied and field installed.
 - f. Coils shall be located in the preheat position upstream of the cooling coil.

D. Refrigeration System

1. Air handling unit and matching condensing unit shall be capable of operation as an R-410A split system air conditioner.
2. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
3. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, filter drier, and suction and liquid connection valves.
4. Unit shall be provided with one independently circuited R-410A variable capacity scroll compressor with thermal overload protection. Variable capacity scroll compressor shall be capable of modulation from 10-100% of its capacity.
5. Each compressor shall be furnished with a crankcase heater and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

6. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
 7. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated suction line.
 8. Electronically commutated motor driven variable speed condenser fans shall be provided for head pressure control and allow operation down to 35°F.
 9. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment.
 10. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 11. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
 12. Installation, Operation and Maintenance manual shall be supplied within the unit.
 13. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
 14. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
- E. Fans -
1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
 2. Blower and motor assembly shall be dynamically balanced and mounted on rubber isolators.
 3. Motor shall be a high efficiency electrically commutated motor.
 4. ECM driven supply fan cfm setpoint shall be set with factory installed potentiometer within the control compartment.
- F. Electrical
1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
 2. Unit shall be provided with standard power block for connecting power to the unit.
 3. Unit shall include a factory installed 24V control circuit transformer.
- G. Filters -
1. Provide removable two inch thick filters easily removable from either side of the unit. All units shall use standard filter sizes. Each unit shall include three sets of 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the coils.
- H. Controls -
1. Unit shall be provided with an internal control panel with separated low and high voltage control wiring and a hinged service access door with tooled entry.
 2. Unit shall be provided with a terminal strip for field installed DDC controls..
 3. Johnson Controls direct digital controls will be provided by the temperature controls contractor.
 4. Provide additional control accessories where scheduled or where required for the installation.

- I. Acceptable Manufacturers – Aaon, Carrier, Trane, York.

2.2 PACKAGED CEILING FANS:

- A. Packaged ceiling fans shall be factory assembled units including fan, motor, housing, prewired plug disconnect, and discharge backdraft damper with capacities, arrangements and accessories as scheduled. When installed flush in ceiling, fan shall be provided with an intake grille. When installed in-line, provide accessories required.
- B. Fan wheels shall be of the centrifugal type, direct connected to a permanently lubricated, radio shielded, thermally protected motor with neoprene torsion mounts to isolate vibration.
- C. Fan and motor shall be enclosed in a baked enamel steel housing suitable for in-line, horizontal or vertical discharge. Housing shall be lined with 1/2-inch acoustical insulation.
- D. When required, intake grille shall be white plastic and shall be removable for cleaning or service.
- E. Furnish necessary ductwork, transitions, eaves, wall or roof caps as scheduled and as required.
- F. Acceptable Manufacturers, - Acme, Carnes, Cook, Greenheck, Ilg, Jenn-Air, Loren Cook, Penn, Twin City Fans.

2.3 ROOF CAPS:

- A. Factory fabricated low silhouette type units, with hood, pedestal and curb mounting base with counterflashing, all fabricated of heavy gage galvanized or aluminum sheet, reinforced with a welded steel frame, finished with 1/2-inch mesh hardware cloth birdscreen at openings. Roof cap shall be rectangular or round in shape, with bottom or side louvered openings, as scheduled.
- B. Units shall be finished with a zinc chromate primer and a rubber base or acrylic enamel finish.
- C. Underside of hood shall have bitumastic anti condensate coating.
- D. Provide with insulated roof curb and gravity backdraft damper. Curb shall be a minimum of 12 inches high, and shall be pitched when installed on sloping roofs to result in a level top of curb.
- E. Acceptable Manufactures - Acme, Carnes, Cook, Greenheck, Jenn-Air, Penn, Nailor, Twin City.

2.4 LOUVERS (FIXED):

- A. Louvers equivalent to Greenheck model ESD-635 drainable type, fabricated from 6063T5 aluminum extrusions of 0.081 in nominal wall thickness. Blades shall be positioned at 35 deg angles approximately on 4 in centers. Each louver shall be equipped with a framed, removable, rear-mounted screen of 0.75 in x 0.051 in expanded, flattened aluminum.
- B. Louvers shall be stationary type with drainable blades in a 6 in louver frame. Each stationary blade shall incorporate an integral drain gutter and each jamb shall incorporate an integral downspout so water drains to blade end} then down the downspouts and out at the louver sill rather than cascading from blade to blade.

- C. Each factory-assembled louver section shall be designed to withstand wind loadings of 25 PSF (100.0 MPH wind equivalent). Louver frames, mullions, and section joints shall be adequately supported from the building structure to withstand this same wind loading.
- D. Louver performance data shall be licensed under the AMCA Certified Ratings Program, and shall bear the AMCA Certified Ratings Seal. This certified performance data shall include airflow pressure loss and water penetration, and shall demonstrate performance equal to or better than the Greenheck model specified.
- E. Louvers shall be supplied with a baked enamel finish applied after a thorough cleaning and preparation of the metal surface. A total dry film thickness of approximately 1.2 mils shall be provided. Color shall be as selected by the Architect from standard color chart.
- F. Provide insulated (2-inch thick) metal blank-off panel(s) for all louvers. Provide open area for all areas noted as active on drawings.
- G. Acceptable Manufacturers: Air Balance, American Warming & Ventilating, Carnes, Greenheck, Ruskin.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION:

- A. Install equipment in strict accordance with manufacturer's recommendations and requirements of other sections.
- B. Coordinate responsibility for providing equipment roof curbs and flashings with roofing contractor. Coordinate curb type with roofing contractor to ensure curb's compatibility with roofing system and with curb-mounted equipment.

3.2 CHARGING SPLIT SYSTEMS:

- A. Test direct expansion system refrigerant piping and machine assembly for leaks before evacuation, dehydration and charging. Perform tests above 60 F. ambient temperature.
 - 1. Remove controls and valves subject to test damage.
 - 2. Perform testing, evacuation and charging of system in accordance with manufacturer's recommendations.
- B. See Section 23 99 00.

3.3 SPACE REQUIREMENTS:

- A. The Contractor shall field measure all existing clearances relative to receiving, transporting and installing equipment where indicated on the drawings. If necessary, the contractor shall disassemble unit and reassemble in final installed position. Such disassembly and reassembly shall be approved by and carefully coordinated with the equipment manufacturer.

END OF SECTION 23 80 00

SECTION 23 85 00 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all necessary labor, equipment, and materials for a complete duct system, including all hardware and accessory devices.
- B. Install instrumentation devices in the duct system, furnished under Section 23 90 00.

1.2 STANDARDS:

- A. Ductwork shall be fabricated, erected and installed and fitted out with accessories in accordance with current editions of the following -
 - 1. Governing Building Codes.
 - 2. NFPA 90A.
 - 3. SMACNA HVAC Duct Construction Standards.

1.3 DEFINITIONS:

- A. Pressure - Velocity Classification - classifications of duct construction as defined in SMACNA HVAC Duct Construction Standards, First Edition, 1985 (Table 1-1).
- B. Insulated Ductwork - externally insulated as specified in Section 23 25 00.
- C. Preinsulated Ductwork - ductwork constructed of insulating material or incorporating insulating material during fabrication.

1.4 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment, clearly indicating exactly what features, options and accessories are being provided.
- B. See Section 23 01 00.

1.5 OPTIONS:

- A. Equivalent area round ducts may be substituted for rectangular ducts serving a single outlet provided the round duct tap is made into the rectangular with a round take-off fitting with integral volume damper as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Galvanized steel sheets, lock-forming quality, ASTM A-525 with galvanized coating for both sides of the sheet.
- B. Black steel sheets - conforming to ASTM A-366.
- C. CPVC - All exhaust duct piping, sizes 6" through 24", shall be CPVC seamless extruded type, equivalent to Harvel Plastics Inc.; trade name Harvel® Corzan® Duct. Exhaust duct shall be extruded from a Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a Cell Classification of 23437 per ASTM D1784. All extruded duct shall have a maximum flame spread rating of 5 or less and a maximum smoke generation of 25 or less per ULC S102.2. All extruded duct shall meet Harvel Plastics Inc. published standards with regard to material and dimensions, and shall carry a maximum temperature rating of 200°F. All extruded duct pipe shall be manufactured in the USA, using domestic materials, by an ISO 9002 certified manufacturer, and shall be stored indoors at the manufacturing site until shipped from the factory. All extruded CPVC duct pipe shall be marked with the manufacturer name or identifying symbol, and the Corzan® CPVC material trademark.
 - 1. Acceptable Manufacturers - Harvel Plastics or approved equivalent.
- D. Proprietary Flanged Transverse Duct Joint Assembly - Ductmate system, applied and installed in accordance with manufacturer's published recommendations.
- E. Duct Sealant - United, Foster, Hardcast, Minnesota Mining Manufacturing.

2.2 FLEXIBLE CONNECTIONS:

- A. Woven nylon, 22 oz./sq. yd., 150 lb. tongue tear strength, 500 lb. tensile strength, flame retardant coating, proof fabric maximum 10-inches long, minimum 4-inches in direction of air flow.
- B. Acceptable Manufacturers – Ductmate, Durodyne, Hardcast, Ventfabrics.

2.3 MOTORIZED DAMPERS:

- A. Louver type with not less than 16 gauge welded steel frames and galvanized finish. Blades shall have interlocking edges, vinyl or neoprene gaskets, and Teflon coated stainless steel thrust washers. Blades shall be edged with neoprene.
- B. Actuators shall be driven by electrically powered motors and shall be sized to operate their appropriate dampers or valves with sufficient reserve power to provide 2-position action. Provide adjustable positive stops or limit switches on each actuator.
- C. Acceptable Manufacturers - Air Balance, Carnes, Empco, Greenheck, Krueger, Louvers & Dampers, Ruskin.

2.4 BACKDRAFT DAMPERS:

- A. Provide heavy-duty shutter type dampers, with galvanized 16 gage or extruded aluminum frame and wind stops, minimum 28 gage galvanized steel or 26 gage aluminum blades, 3/16-inch steel shaft with "Oilite" bronze bearings, roll formed blade edged with felt sealer, blades linked with tie bar and adjustable counter weight, to allow full blade position parallel to air flow under full air flow with gravity closing of dampers on reverse flow.
- B. Provide frames for required mounting and access doors required for complete adjustment of balance weight.
- C. Fan manufacturer's backdraft dampers are acceptable where furnished and installed in conjunction with exhaust fan installations scheduled, and similar to above.
- D. Acceptable Manufacturers - Air Balance, Carnes, Empco, Greenheck, Krueger, Louvers & Dampers, Ruskin.

2.5 VOLUME DAMPERS:

- A. Provide manual balancing dampers with position locking mechanism as shown and as required to balance the air flow to each outlet or from each inlet.
- B. Construction in accordance with SMACNA manuals.

2.6 COMBINATION FIRE/SMOKE DAMPERS:

- A. Damper assembly with galvanized steel structural frame, galvanized steel blades, stainless steel or bronze bearings, extruded silicone rubber edge seals and flexible, compression type stainless steel jamb seals, and actuator, constructed in accordance with NFPA Standard No. 90-A.
 - 1. Fire resistance rating:
 - a. 1 ½ hour rating for installation in barriers with fire resistive rating less than 3 hours.
 - b. 3 hour rating for installation in barriers with fire resistive rating of 3 hours or more.
 - 2. Fire closure temperature: 350°F.
 - 3. Leakage Class I or II.
 - 4. Minimum velocity rating of 2000 fpm.
 - 5. Minimum pressure rating of 4 in. w.g.
- B. Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
- C. Entire assembly shall bear UL 555S, Class II label. Provide a 120 vAC, UL 864 listed, external mounted, electric motor actuator. A UL33 heat actuated link shall provide closure and containment independent of actuator positioning or signalling.
- D. Damper and actuator assembly shall be factory-tested to assure proper operation.

Acceptable Manufacturers - Air Balance, Greenheck, Nailor Industries, Inc., Prefco, Ruskin.

2.7 FLEXIBLE DUCT:

- A. Flexible duct shall be light weight duct formed with a resilient core of continuous, chlorinated polyethylene inner air barrier and insulated with resilient 1 1/2-inch thick fiberglass and jacketed with a tough scrim-reinforced aluminum vapor barrier and containing a totally encapsulated reinforcing wire helix.
- B. Listed as UL 181, Class 1 duct. Complies with NFPA 90A.
- C. Provide flexible duct clamps of self-locking nylon, or stainless steel with swivel action screw.
- D. Acceptable Manufacturers - Flexmaster, Thermaflex.

2.8 BRANCH DUCT TAKE-OFF:

- A. A round or rectangular take-off made from a rectangular supply, return or exhaust duct shall utilize a fitting having rectangular opening with 45° transition on main duct to round or rectangular collar on branch duct side of fitting. Fitting shall be equivalent to Wichita Sheet Metal Supply Co. model HETO.
- B. A round take-off from a round supply, return or exhaust duct shall utilize a fitting having round opening with 45° transition on main duct to round collar on branch duct side of fitting.
- C. Fitting shall include a butterfly damper with quadrant operator in branch duct collar, with stand-off platform to extend quadrant beyond duct wrap for insulated duct. Provide a wing nut at each end of damper shaft.

2.9 SHEET METAL HARDWARE:

- A. Quality and configuration to conform to Ventfabrics, Inc. Piece number and description, as listed-
 - 1. Ventfabrics No. 641 damper regulator, self-blocking, die- cast, secure to sheet metal on exposed and concealed ductwork above accessible ceilings.
 - 2. Ventfabrics No. 677 damper regulator, self-blocking die- cast, chrome plated cover. To control ductwork located above an accessible ceiling or confined in wall spaces. Control from conditioned space.
 - 3. Ventfabrics No. 607 damper end bearing, die-cast for rectangular ducts, with bearing and opening for shaft inclusion.
 - 4. Ventfabrics No. 609 end bearing, die-cast for cylindrical ducts, with suitable gaskets, bearing and recess for shaft insertion.
 - 5. Ventfabrics No. 615 and 616 tandem placed U-bolts, with washer and nuts to fix damper rod to damper blade.
 - 6. Ventfabrics No. 699 die-cast instrument test hole, with screw, cap and gasket.
 - 7. Ventfabrics No. 611, 160 F. fusible link, 15 lb. load capacity.
 - 8. Ventfabrics No. 613, 212 F. fusible link, 15 lb. load capacity.
 - 9. Ventfabrics No. 90, sash lock, cadmium plated stamp steel construction, for use on reach-thru doors.
 - 10. Ventfabrics No. 220, die-cast door pulls for use on reach- thru access doors.

11. Ventfabrics No. 150, 2 x 1-11/16-inch galvanized duct hinges, minimum 2 hinges per door, for use on reach-thru access doors.

B. Acceptable Manufacturers - Duro-Dyne, Ventfabrics, Inc., Young Regulator.

2.10 FABRICATION:

A. Ductwork -

1. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, latest edition.
2. Each duct system shall be constructed for the specific duct pressure of the system.
3. Pressure-Velocity Classification and seal class shall be as follows:
 - a. Supply, return and general exhaust ductwork shall be galvanized sheet metal constructed per requirements for the 2" water gage pressure class and seal class "C". Exposed make-up air duct to range hoods shall be stainless steel.
 - b. Fume hood exhaust ductwork:
 - 1) Fume hood exhaust ductwork shall be CPVC, constructed per requirements for the 2" water gage pressure class.
4. Seal supply, return, and general exhaust ductwork with Hardcast #601 water based, UL listed sealant or approved equivalent, in accordance with SMACNA HVAC Duct Construction Standards for required static pressure construction class and seal class.

B. Rectangular duct fittings-

1. Elbows, tees and splits shall be constructed with square turns or radius turns which shall have a centerline radius 1-1/2 times the width of the duct as an absolute minimum.
2. If square turns are used, fabricate and install hollow formed turning vanes in each turn for elbows turns for elbows having equal inlet and outlet dimensions.
3. Where elbows have unequal inlet and outlet dimensions, turning vanes shall have leading and trailing edges parallel with the air flow and shall be high efficiency profile type similar to those manufactured by the Aerodyne Company. Vane assemblies shall be made with Aerodyne side rails, and vanes shall be installed on design centers as for the vanes across the full diagonal dimension of the elbow. Cut center section of each rail as recommended by manufacturer so that the required position adjustment may be made.

C. Round duct - Spiral seam, in accordance with SMACNA 1985 Duct Construction Standard.

1. Up to 15-inch: 26 gage steel spiral seam.
2. 15 thru 26-inch: 24 gauge steel spiral seam.
3. 28 thru 36-inch: 22 gauge steel spiral seam.
4. 38 thru 50-inch: 20 gauge steel spiral seam.
5. 52 thru 60-inch: 18 gauge steel spiral seam.
6. Joints-
 - a. Beaded sleeve joints on spiral duct, 2-inch minimum lap.

D. Round ductwork fittings-

1. Each 90 degree elbow shall be 2-piece welded, die formed construction, and shall have a center-line radius of not less than 1.5 times the duct diameter.
2. Each elbow between 45 and 90 degrees shall be 3-piece construction, with same center-line radius requirements.

3. Provide combination lateral elbow and tee, 90 degree tees, conical tees, double wye's and reducers each as required.
 4. Fittings shall be constructed from material 2 gauges heavier than spiral pipe. For systems up to 4 inches static pressure seams shall be spot welded and internally sealed. For systems greater than 4 inches static pressure seams shall be continuously welded.
- E. Fume hood exhaust duct –
1. CPVC ductwork.
 - a. Joints – Solvent welded.
 - b. Round ductwork fittings –
 - c. Each elbow shall have a center-line radius of not less than 1.5 times the duct diameter.
 - d. Provide combination lateral elbow and tee, 90 degree tees, conical tees, double wye's and reducers, each as required.

2.11 GRILLES, REGISTERS AND DIFFUSERS:

- A. Provide as scheduled.
- B. Increase size when required for installation in lined ductwork.
- C. Air Distribution-
 1. Supply units shall be designed to provide the throw and spread required with no apparent drafts or excessive air movements within the ventilated or air conditioned spaces.
 2. Provide air distribution accessories required to effect these conditions as part of the supply unit.
- D. Noise-
 1. The noise spectrum of the supply units shall be no higher than N.C.-35 as defined in the latest issue of ASHRAE Guide.
 2. Units causing excessive air movement, drafts or objectionable noise shall be replaced at no cost to the Owner.
- E. Volume Control - Furnish supply outlets with key operated volume dampers, unless otherwise specified.
- F. Gaskets - Flanges of diffusers, registers and grilles shall be gasketed with foam rubber gaskets to prevent leaking and smudging.
- G. Finish - Furnish grilles, registers, and outlets in factory baked white enamel finish, also suitable as prime coat for finish painting in the field, except as otherwise specified or scheduled.
- H. Acceptable Manufacturers - Air Concepts, Anemostat, Barber- Colman, Buensod-Stacy, Carnes, Carrier, Conners, Krueger, Metalaire, Titus, Tempmaster, Trane, Tuttle & Bailey.

PART 3 - EXECUTION

3.1 MATERIAL APPLICATION:

- A. Galvanized steel sheets - use for fabrication of the following-
 - 1. Supply, return, exhaust ducts except as otherwise specified.
 - 2. Housings for coils, dampers, filters and fans.
 - 3. Volume control dampers.
 - 4. Intake and exhaust plenums, roof caps and goosenecks.
 - 5. Hangers for ducts.
 - 6. Flashing and counterflashing.
- B. Black steel sheets - use for fabrication of the following-
 - 1. Fire damper sleeves.
- C. CPVC Ductwork - use for fabrication of the following -
 - 1. Fume hood exhaust systems as described herein.

3.2 DUCT SIZE AND ROUTING:

- A. Ductwork sizes and routing shown on drawings are schematic. Offset, flatten and maintain duct area, and reroute ducts where required to maintain headroom, clear light fixtures, pipes, conduits, structure and other construction.

3.3 INSTALLATION:

- A. Flexible connectors-
 - 1. Install on inlet and outlet of each piece of air handling equipment.
- B. Flexible duct-
 - 1. Secure to duct, apply heat resistant fire retardant compound to male end of each piece of duct, insert into flexible duct, secure with draw in accordance with manufacturer's instructions.
 - 2. Flexible ducts shall have developed length of not more than 4-feet and be supported to eliminate sagging and afford smooth 1-1/2 center-line (minimum) bends.
 - 3. Flexible duct shall not be installed above inaccessible ceilings or in other concealed locations.
- C. Volume dampers-
 - 1. Install at each split in each run of duct.
- D. Sheet metal hardware-
 - 1. Install as required and in accordance with manufacturer's recommendations.
- E. Air devices-
 - 1. Each air outlet of each duct system shall be equipped with a balancing damper, either integral with the device or located in the individual branch duct to balance the airflow from that device.
 - 2. These devices shall be installed after the duct systems are thoroughly cleaned, with suitable accessories as specified or required for proper air distribution.
- F. Automatic dampers -

1. Install automatic dampers except dampers specified as integral parts of factory fabricated air handling unit components.
- G. Fume Hood Exhaust -
1. Pitch at a minimum of 1/4-inch per foot to drain toward the fume hood.
 2. All changes in direction shall be made with radius elbows.
 3. Utilize CPVC duct manufacturer's couplings, offsets, transitions, flanges, dampers, plenums and special fittings. Join sections with solvent cement in strict accordance with duct manufacturer's instructions.

3.4 ERECTION:

- A. Hangers-
1. Provide round hangers, strap hangers, or trapeze shelf hangers in accordance with SMACNA standards.
 2. Rectangular ducts 0 thru 47-inches wide, use 18 gage galvanized strap, 10 feet on center, 1-inch strap.
 3. Rectangular ducts 48-inches and wider, use trapeze hangers formed of angle iron under duct rigidly and securely supported to building structure by threaded rods, installed per SMACNA standards.
 4. Cylindrical ducts - 0 thru 36-inches in diameter, use 18 gage galvanized strap, 10 feet on center, 1-inch strap.
 5. Cylindrical ducts over 37-inches in diameter, use 16 gage galvanized strap, 10 feet on center, 2-inch strap.
 6. For vertical ducts - 0 thru 24-inches in any dimension, use 1 x 1 x 1/8-inch galvanized angle. Secure angle to duct at each floor level, rest angle on building structure.
 - a. Ducts 25-inches thru 60-inches use 1 1/2 x 1 1/2 x 3/16-inch galvanized angle.
 - b. Ducts over 61-inches use 2 x 2 x 3/16-inch galvanized angle.
 - c. Support to the building construction and secure to duct.
 7. For cylindrical, double wall ducts, refer to drawings and SMACNA standards.
 8. Support flexible ducts with 18 gage, 1-inch wide galvanized straps, with span lengths as short as necessary to prevent sagging.
 9. CPVC fume hood exhaust duct - use galvanized split clamps and hangers. Hanger material and spacing shall be in accordance with the duct manufacturer's recommendations for each duct size.

3.5 ACCESS DOORS:

- A. Provide duct access doors as required to clean kitchen hood exhaust ductwork. In other ducts, provide duct access doors as required to service each item of equipment mounted in the ductwork, including but not limited to-
1. Fire and combination fire/smoke dampers.
 2. Automatic control dampers.
 3. Coils.
 4. Volume dampers.
 5. Filters.
 6. Controls devices.

- B. Duct access doors shall be complete with latches, gaskets and frames, and shall be constructed in accordance with SMACNA manuals. Provide hinged doors wherever practicable, removable type otherwise. Access doors in insulated ducts shall be insulated.
- C. Furnish access doors as specified in Section 23 01 00 for installation in the general construction wherever duct access doors would not otherwise be accessible.
- D. Access doors shall be generously sized for the purpose intended. Demonstrate suitability of each to the satisfaction of the Architect.

3.6 TESTING:

- A. Mechanical contractor shall test grease hood exhaust duct in accordance with the requirements of the 2006 International Mechanical Code. The duct shall be tested for leakage and liquid tightness, prior to concealment or insulating of any portion of the duct system.
- B. See Section 23 99 00 for additional testing requirements.

3.7 COMPLETION:

- A. Complete each entire duct system, perform testing and cleaning operations, and leave each system in a condition with the coils cleaned, the filters clean, and debris and foreign material removed from the duct system.
- B. Install a suitable air diffuser, grille, or similar device to cover each duct outlet.
- C. Paint bare metal interior surfaces of ducts which can be seen through air inlets or outlets with a flat black paint.
- D. Operate system and prove them to be free from excessive noise, free from perceptible air leaks, free from vibration, and capable of delivering the air quantities scheduled.

END OF SECTION 23 85 00

SECTION 23 99 00 - TESTING, ADJUSTING AND BALANCING (HVAC)

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. This Section applies to the testing, adjusting, and balancing of all HVAC air and water systems in Divisions on 23 of the Specifications. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- B. The mechanical contractor shall perform system cleaning, testing and start-up before commencement of the test and balance work.

1.2 QUALIFICATIONS:

- A. Testing, adjusting and balancing (T-A-B) of systems shall be performed by a competent and experienced personnel, certified by the Associated Air Balance Council or National Environmental Balancing Bureau in those testing and balancing disciplines required for this project, having done similar work in the past, and whose qualifications shall be subject to approval.

1.3 SUBMITTALS:

- A. Submit names and qualifications of all persons proposed for testing, adjusting and balancing of mechanical systems and equipment. T-A-B work shall not begin until approval of such submittal is obtained.
- B. Submit report format as described below. T-A-B work shall not begin until approval of such submittal is obtained.
- C. See Section 23 01 00.

1.4 REPORTS:

- A. Provide reports and certificates required in each category of testing, adjusting and balancing, signed both by the technician performing the work and the Contractor as representing accurate, factual data, based on readings on the job. Include a listing of the instrumentation used for the procedures along with proof of instrument calibration. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- B. Reports shall be submitted on 8-1/2 x 11-inch paper format. Submit format for recording data for approval prior to use. Include a copy of final reports in each Operating and Maintenance Manual.

PART 2 - PRODUCTS**2.1 EQUIPMENT AND MATERIALS:**

- A. Provide all meters, instruments, equipment and materials necessary for performance of tests.
- B. Testing apparatus, not part of the permanent installation, shall remain the property of the Contractor.
- C. Provide gaskets, lubricants, and other expendable materials required to be replaced during the execution of this work.
- D. Fixed-pitch pulleys required for fan adjustments shall be provided on an exchange basis by the party responsible for the equipment installation (applies to new equipment only).

PART 3 - EXECUTION**3.1 MECHANICAL CONTRACTOR RESPONSIBILITIES PRIOR TO COMMENCEMENT OF TEST AND BALANCE WORK:**

- A. Clean all dirt and debris from equipment.
- B. Service all bearings, gear boxes, wearing surfaces and other equipment components requiring lubrication as recommended by the equipment manufacturer.
- C. Check all motor driven equipment for proper rotation.
- D. Tag all valves and label all equipment.
- E. Clean all plenums and ductwork.
- F. Perform start-up on all equipment to insure proper operation.
- G. Replace air filters.
- H. Check all refrigerant systems to insure that they are properly charged with refrigerant and oil, and that they are moisture free.
- I. Check all control devices to insure that they are installed correctly and are operating properly.
- J. Make preliminary settings and adjustments as required to insure all systems will operate satisfactorily while test and balance work is performed.
- K. Provide a set of final shop drawings to the test and balance agency.
- L. Furnish and install additional balancing valves, dampers, test plugs and gauge cocks if the test and balance agency determines that such additional items are required to properly balance the systems.

3.2 TEST AND BALANCE PERSONNEL RESPONSIBILITIES PRIOR TO COMMENCEMENT OF TEST AND BALANCE WORK:

- A. Obtain design drawings, specifications, and submittals of mechanical equipment and temperature control diagrams, and become thoroughly acquainted with the design intent.
- B. Walk the systems to become familiar with equipment locations and to determine variations of the installation from design.
- C. Prepare schematic diagrams of ductwork and piping systems as installed to facilitate reporting.
- D. Prior to beginning of testing, adjusting and balancing procedures, schedule and conduct a conference with the Engineer and representatives of the installers of the mechanical and temperature control systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.
- E. Schedule testing, adjusting and balancing procedures so that air conditioning systems are balanced during summer season and heating systems are balanced during winter season, including at least a period of operation at outside conditions within 5° F wet bulb of maximum summer design condition, and within 10° F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

3.3 MECHANICAL CONTRACTOR RESPONSIBILITIES DURING TEST AND BALANCE WORK:

- A. The mechanical contractor shall cooperate and assist the test and balance personnel in performing the test and balance work. He shall also provide craftsmen and/or technicians of the various trades as required to assist the test and balance agency in performing the test and balance work. The craftsmen and/or technicians provided shall be familiar with the installed systems.

3.4 TEST AND BALANCE PERSONNEL RESPONSIBILITIES DURING TEST AND BALANCE WORK:

- A. Provide temperature controls contractor with temperature, pressure and flow measurements as required for the calibration and verification of temperature controls system operation.
- B. Perform testing, adjusting and balancing procedures for the various systems as described herein and in accordance with applicable standards of the National Environmental Balancing Bureau, Associated Air Balance Council, and the American Society of Heating and Refrigeration Engineers 1991 Handbook, Chapter 34.

3.5 SYSTEM VERIFICATION AND CALIBRATION:

- A. Provide attendance by a qualified technician to work in cooperation with other participants to calibrate, integrate, and verify operation of all components and equipment described in this work.

1. Make all repairs, adjustments and programming changes necessary to accomplish the desired operation of the HVAC systems.
2. See MECHANICAL SYSTEM VERIFICATION AND CALIBRATION of Specification Section 23 01 00 for complete requirements.

3.6 HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS:

Note - items marked TBA shall be the responsibility of the Test and Balance Agency; items marked MC shall be the responsibility of the Mechanical Contractor.

1. TBA - Balance all new or existing supply and exhaust air systems in accordance with SMACNA and AABC standards, by the use of a direct reading instrument such as "Anemotherm" or "Velometer" which has been properly calibrated.
 2. TBA -The quantity of airflow at each inlet or outlet shall be within 10 percent of the design cfm shown on the Drawings.
 3. TBA - Blank-off sufficient filter area to simulate a dirty filter condition (maximum pressure drop across filter bank).
 4. For variable volume systems, furnish typewritten data for both maximum cooling and maximum heating air delivery, tabulating –
 - a. Quantity of air in cfm at each air supply outlet.
 - b. Dry bulb temperature of the supply air.
 - c. Outdoor dry and wet bulb temperature at the time the above tests are conducted.
 5. TBA - Furnish typewritten data tabulating-
 - a. Quantity of air in cfm at each air outlet and inlet.
 - b. Dry bulb temperature in each room.
 - c. Dry bulb temperature of the supply air.
 - d. Outdoor dry and wet bulb temperature at the time the above tests are conducted.
 6. MC - Adjust belts, sheaves and the alignment of air handling equipment.
 7. MC - Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
 8. MC - Oil or grease bearings in accordance with manufacturer's instructions.
 9. TBA -Furnish typewritten data taken at each blower coil unit, for both clean and dirty filter conditions, tabulating-
 - a. Total quantity of supply air in cfm.
 - b. Total quantity of return air in cfm.
 - c. Total quantity of outside air in cfm.
 - d. Rpm of each fan or blower.
 - e. Rpm of each motor.
 - f. Voltage and ampere input of each motor (one reading for each phase leg on 3 phase motors).
 - g. Pressure in inches water gage at inlet and discharge of each fan or blower.
 - h. Furnish manufacturer's fan curve with calculated operation condition shown thereon.
 10. TBA - Furnish air handling unit test data for variable volume systems at both maximum system air delivery and maximum turn-down.
- B. Outside/Return Air Mixing Chambers-
1. TBA, Test each outside/return air mixing chamber for air handling units to prove actual air mixture conditions as specified. Balance return and outside air quantities for mixing plenums to the flows specified.

- a. TBA, Outdoor temperature at the time the above tests are conducted.
- C. Pumps:
1. MC - Adjust, align and service pumps and motors in accordance with manufacturer's recommendations.
 2. TBA - Furnish typewritten data tabulating-
 - a. Quantity of water circulated by each pump in gpm.
 - b. Suction and discharge pressures across each pump in psi.
 - c. Voltage and ampere input of each motor (one reading for each phase leg on three phase motors).
 - d. Horizontal, vertical and angular misalignment of pump and driver after 2 hours operation and after remaining idle overnight.
 - e. Furnish manufacturer's pump curve with calculate operating condition indicated thereon.
- D. HVAC Water coils:
1. MC - Clean exterior surface of coil tubes and fins. Flush interior of tubes with water until water runs clean. Straighten fins.
 2. TBA - Furnish typewritten data tabulating-
 - a. Entering and leaving water temperature.
 - b. Quantity of air in cfm.
 - c. Face velocity in fpm.
 - d. Dry and wet bulb air temperature entering and leaving coil (for heating and cooling operation).
 - e. Quantity of water circulated through coil in gpm.
- E. HVAC Water Piping Systems:
1. MC - Test hydrostatically to pressure of 75 psi in excess of the operating pressure.
 2. MC - Flush and clean piping until the water runs clean.
 3. MC - Repair leaks and retest.
 4. MC - Test shall be repeated until the entire system is tight.
 5. MC - Final pressure test shall be maintained for at least 24 hours.
- F. Exhaust Fans -
1. MC, Adjust, align and service exhaust fans in accordance with manufacturer's recommendations and as required to achieve proper operation. Oil or grease bearings in accordance with manufacturer's instructions. Adjust belts and sheaves. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
 2. TBA, Furnish typewritten data for each exhaust fan, tabulating-
 - a. Total quantity of exhaust air in cfm.
 - b. Rpm of fan.
 - c. Rpm of motor.
 - d. Voltage and ampere input of fan motor (one reading for each phase leg on 3 phase motors).
 - e. Pressure in inches water gage at inlet and discharge of fan.

END OF SECTION 23 99 00

SECTION 23 25 00 - INSULATION (MECHANICAL)

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Thermal insulation of piping systems, plumbing, casings and equipment installed under other Sections of these Specifications.

1.2 REFERENCE STANDARDS:

- A. ASHRAE 90A - 1980, Section 5.
- B. NFPA 90A, Air Conditioning and Ventilation Systems.
- C. UL Guide No. V.8.15 (Jackets, Adhesives and Sealers).
- D. SMACNA, Sheet Metal and Air Conditioning Contractors National Association.

1.3 SUBMITTALS:

- A. Submit manufacturer's product data on insulation materials, jackets, accessory materials, adhesives, tapes, etc. Submit a schedule for each class of insulation specified, indicating product, thickness, quantities, sizes, installation details, and surfaces to which each class is to be applied.
- B. See Section 23 01 00.

1.4 QUALIFICATIONS:

- A. Insulation shall be installed by a firm whose principal business is the application and installation of thermal insulating material on piping and duct systems. Materials shall be by recognized manufacturers and shall be installed by skilled mechanics in accordance with manufacturer's standard published instructions except as otherwise specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Accessory Materials - Childers, Fosters, P.K. Insulation, Vimasco.

- B. Insulation Material - Armstrong Cork, CertainTeed, Delta Systems, Inc., E.O. Wood, Fibrex, Knauf Fiber Glass, Manville, Owens-Corning Fiberglass, Partek.

2.2 ACCESSORY MATERIALS:

- A. Hanger Adhesive - Foster 55, red-brown, or approved equivalent.
- B. Insulating Cement - P.K. Insulation Quick Coat or One Coat, or approved equivalent.
- C. Metal Bands - 1/2-inch wide, 0.20-inch thick aluminum.
- D. Flexible Cellular Insulation Adhesive - Armstrong 520 or Foster 82-40, or approved equivalent.
- E. Glass Fabric Cloth - 8 ounce per square yard sized woven cloth.
- F. Glass Fabric Cloth Jacket Sealer, UL listed lagging adhesive, white - Foster 30-36, or Childers CP-50 pigmented, or approved equivalent.
- G. Vapor Barrier Mastic, White - Foster 30-35 or Childers CP-30, or approved equivalent.
- H. Weather Barrier Mastic, White - Foster 35-00 or Childers CP-10, or approved equivalent UL classified outdoor grade elastomeric vinyl mastic.
- I. Fiberglass Insulation Bonding Adhesive, Amber-Foster 85-15 or Childers CP-82, or approved equivalent.
- J. Mechanical Surface Fasteners – Benjamin Foster, Duro Dyne, Manville.

2.3 INSULATION JACKETS:

- A. ASJ Jacket - All Service Jacket - Vinyl coated and embossed vapor barrier laminate of 40 pcf white kraft, aluminum foil, and flame snuffing adhesive, reinforced with glass fibers, 0.05 permeability rating.
- B. PVC Jacket - 20 mil minimum thickness polyvinyl chloride pipe and fitting jacketing, UV resistant with maximum of 25/50 flame/smoke spread rating per ASTM 84. Install with waterproof solvent welding contact adhesive, vapor barrier mastic adhesive, and PVC tape. Do not staple or penetrate vapor barrier.
 - 1. Equivalent to Johns Manville Zeston.

2.4 TYPE FDL INSULATION:

- A. Fiberglass Duct Liner, blanket material in roll form, meeting the requirements of ASTM C1071 and the additional following requirements.

1. Have a potential heat value not exceeding 3500 btu/lb when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.
2. Maximum rated velocity not less than 5000 FPM when tested in accordance with ASTM C 1071.
3. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C 1138, G 21 and G22.
4. Have a maximum thermal conductivity(k-value), at 75°F mean temperature, of .24 Btu.●in/hr.●sq.ft.●°F.
5. Sound absorption coefficients and NRC shall meet or exceed the following when tested in accordance with ASTM C 423 using an “A” mounting.

Thickness	Type	Absorption Coefficients @ Octave Band Frequencies (Hz)							NRC
		125	250	500	1000	2000	4000		
1/2"	200	.05	.15	.35	.61	.75	.88	.45	
1"	150	.06	.27	.66	.87	.98	.99	.70	
1-1/2"	150	.18	.53	.97	1.06	1.06	.90	.90	
2"	150	.24	.74	1.12	1.11	1.07	1.08	1.00	

- B. Fiberglass Duct Liner shall be equivalent to Certaineed Tough Gard R.

2.5 TYPE FDB INSULATION:

- A. Foil Faced Fiberglass Duct Wrap Blanket, UL labeled, reinforced foil kraft vapor barrier jacket, 0.30 K factor 75°F, mechanically fastened to duct using insulation pins welded to duct. Insulation pins shall not penetrate to the inside of ducts.
- B. Conforming to FS HH-I-558B, Form B, Type 1, Class 6, ASTM C- 553.

2.6 TYPE FBW INSULATION:

- A. Equivalent to 3M Fire Barrier Duct Wrap 615+, Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches for ventilation and grease duct applications.. Two 1-1/2" thick layers shall be applied directly to grease and air ducts to provide a 2-hour fire rating. Utilize filament tape and aluminum foil tape, carbon steel or stainless steel banding material, bulk mineral wool, silicone sealant and copper coated steel insulation pins as recommended and provided by the insulation manufacturer for the specific installation.
- B. Conforming to NFPA 96, ISO 6944, ASTM C-518, C-1338, E-84, E-119, E-136, E-2336 and E-814.
- C. Acceptable Manufacturers: Minnesota Mining Manufacturing (3M), Nelson, Premier, Unifrax.

2.7 TYPE FPC INSULATION:

- A. Fiberglass Pipe Covering, 0.23 K factor at 75 F., molded in cylindrical form to fit pipe snugly, sectional one-piece construction, with factory applied flame resistant vapor barrier jacket with double self-sealing flap.
- B. Conforming to FS HH-I-558B Form D, Type 3, Class 12 and ASTM C547.

2.8 TYPE PFP INSULATION:

- A. Plastic Flexible Pipe Covering - Flexible closed cell fire resistant foamed plastic material, 0.10 water vapor permeability per ASTM E96 procedure A, , 0.27 K factor at 75°F per ASTM C177 or C518, 5% water absorption by weight per ASTM D1056, molded in cylindrical form to fit pipe snugly. The insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E84-91A. The insulation shall be equivalent to AP Armaflex.

2.9 PIPE INSULATION SADDLES:

- A. Provide 180 degree, 16 gauge galvanized steel protection saddle, 12 inches long, at individual pipe hanger support locations.
- B. Provide 360 degree, 16 gauge galvanized steel protection saddle, 12 inches long, at each pipe which is clamped to a trapeze hanger.

2.10 HANGER SHIELDS:

- A. Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 degree, 24 gage minimum sheet metal hanger shield with insert of high density, 100 psi, waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 1-inch spacing between sleeve and insulation shield. Pack annular space between sleeve and shield as specified under "Fire-Stopping" in the Section 23 01 00. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 1-inch beyond penetrated surface and escutcheon.

2.11 ADHESIVES, MASTICS AND SEALANTS:

- A. Utilize materials recommended by insulation manufacturer for the application.
- B. 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.

2.12 PIPE INSULATION FITTINGS:

- A. Fittings shall be premolded of the same material and thickness as the pipe covering and provided with a matching vaporproof barrier, or build up the fittings from segments of pipe

insulation or fibrous glass blanket to the proper thickness and then finish with fire retardant tape and vaporproof barrier. Fittings so covered shall be finished with a fire retardant covering to form a smooth, neat appearance similar to that on the straight length of pipe.

- B. Valves, strainers, expansion tanks, and similar appurtenances shall be insulated as specified for fittings except that valve bonnets and strainer cleanouts need not be insulated.
- C. One-piece premolded PVC fitting and valve covers may be provided in lieu of fitting jacketing specified.
- D. Where Type ASJ jacketing is specified, one-piece premolded PVC fitting and valve covers may be provided in lieu of fitting jacketing specified.

PART 3 - EXECUTION

3.1 VAPOR SEALED PIPE INSULATION APPLICATION:

- A. Apply insulation only to clean dry pipe after it has been thoroughly tested. Each section of insulation shall be firmly butted together with the end surface of a section of covering having the entire surface buttered with vapor barrier cement and the adjacent end surface of the next section of covering pushed tight to this mastic and vapor sealed.
- B. In areas subject to physical abuse, such as gymnasiums, and when recommended by insulation manufacturer, apply outwardly clinched staples, minimum three per length of insulation. Seal all staple locations with white vapor barrier cement.
- C. At points where pipe hangers occur, insulation damage shall be prevented.

3.2 FLEXIBLE FOAMED PLASTIC PIPE INSULATION APPLICATION:

- A. Insulation shall be cylindrical without longitudinal joint and slipped over the pipe prior to erection wherever possible. Seal circumferential butt joints with flexible tubing adhesive. Where slip-on technique is not possible, insulation shall be slit longitudinally, applied to pipe, and longitudinal and circumferential joints sealed with flexible tubing adhesive.

3.3 DOMESTIC COLD AND HOT WATER PIPING:

- A. Insulate in their entirety except do not insulate 1/2-inch and smaller branches in pipe chases serving single fixtures or horizontal stubouts directly to fixtures from pipe chases or chrome plated pipe.
- B. Insulate hot and cold water and waste piping beneath handicapped sinks. Provide manufactured piping covers consisting of flexible vinyl insulation with white finish and access to piping, equivalent to Handi Lav-Guard manufactured by Truebro, Inc.

- C. Utilize PFP insulation for hot water below grade, FPC insulation for cold and hot water above grade.

3.4 COLD DRAIN PIPING:

- A. Insulate condensate drain piping completely from the unit drain pan to the point of connection to the sanitary waste system.
 - 1. Exception - Condensate drain piping inside of mechanical rooms does not require insulation.
- B. Cold Condensate or Electric Water Cooler Drains – Insulate sanitary waste above grade from drain receiving cold liquid to point of connection to vertical stack or sanitary waste affording dilution adequate to preclude condensation on uninsulated pipe, including "P" trap and vertical piping down to the first elbow.
- C. Rain Water Drain Piping - Insulate only those portions of the downspouts above grade which run horizontally, including the elbow turned down and the elbow turned up, to and including portions of the roof drains below the roof and vertical piping down through the first elbow.

3.5 DUCT INSULATION:

- A. Insulate ductwork as scheduled in this Section. Material shall be as specified for each insulation class.
- B. Provide access door insulation so that doors can be opened without damaging insulation.
- C. Install type FBW insulation in strict accordance with the manufacturer's recommended installation procedure for grease and air duct for zero clearance to combustibles and 2-hour rated duct enclosure. The completed installation shall be in accordance with the product's UL listed assembly.
- D. Do not insulate preinsulated ductwork or flexible runouts.

3.6 DUCT LINER:

- A. Fabrication and installation shall conform to manufacturer's recommendations and to the requirements of the latest edition of the North American Insulation Manufacturers Association's *Fibrous Glass Duct Liner Standard*, or of the Sheet Metal and Air Conditioning Contractors National Association *HVAC Duct Construction Standards - Metal and Flexible*) or the manufactures recommendations.
- B. All portions of duct designated to receive duct liner shall be completely covered with duct liner. All joints shall be neatly butted and there shall be no interruptions or gaps. Duct liner shall be installed with the black surface treatment exposed to the air stream.

- C. Duct liner shall be adhered to the sheet metal with 90% (minimum) coverage of adhesive complying with the requirements of ASTM C 916.
- D. All transverse edges that are not to receive sheet metal nosing shall be coated. Longitudinal joints shall occur at the corners of ducts. If duct size and standard duct liner product dimensions make exposed longitudinal joints necessary, such joints shall be coated with adhesive designated for duct liner application and which meets the requirements of ASTM C 916. Such joints shall be additionally secured with mechanical fasteners in accordance with NAIMA FGDLs, or SMACNA HVAC DCS as if they were transverse joints.
- E. Duct liner shall be additionally secured with mechanical fasteners complying with the requirements NAIMA FGDLs or SMACNA HVAC DCS and of the correct type for the duct liner being installed. Fasteners shall be weld-secured, shall be installed perpendicular to the duct surface and shall penetrate to the outside of ducts. Mechanical fasteners shall not compress the insulation more than 1/8" (3 mm) based on nominal insulation thickness. Fastener spacing with respect to interior duct dimensions shall be in accordance with NAIMA FGDLs or SMACNA HVAC DCS. Fastener heads or washers shall have a minimum area of 0.75 in² (484 mm²), with beveled or cupped edges to prevent their cutting into the duct liner.
- F. Where air velocities exceed 4000 fpm (20.3 m/sec), metal nosing (either channel or "zee" profile) shall be installed on upstream edges of liner duct sections.
- G. Metal nosing shall be securely installed over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct.
- H. Duct liner in roll form shall be folded and compressed in the corners of rectangular duct sections, or shall be cut and fit to assure a lapped, compressed corner joint
- I. Duct liner in sheet form shall be cut and fit to assure tight, over-lapped corner joints. Top pieces of liner shall be supported at the edges by the side pieces
- J. Any damage to the air stream surface must be repaired by coating the damaged area with adhesive or coating designed for duct liner application. Adhesive or coating shall meet requirements of ASTM C916
- K. Field Quality Control
1. Upon completion of installation of lined duct and before HVAC system start-up, visually inspect the ductwork and verify that duct liner has been correctly installed. Confirm that the duct system is free from construction debris.
 2. After the lined duct system is completely installed and ready for service, conduct a final inspection of the entire system. This inspection should include, at minimum, the following steps:
 3. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris.
 4. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.
 5. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork.

6. Turn the HVAC system on and allow it to run until steady state operation is reached.
7. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.

L. Protection

1. Contractor' employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.
2. The contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.7 DUCT INSULATION SCHEDULE:

Note: All ductwork shall be either insulated or lined unless specifically noted otherwise below or on plans.

		TYPE	THICKNESS (Inches)
A.	Rectangular Supply Duct Inside Building	FDL	½
B.	Rectangular Return Duct Inside Building	FDL	½
C.	Round Supply Duct	FDB	1 ½
D.	Rectangular Exhaust Duct	FDL	1/2
E.	Round Exhaust Duct	---	---
F.	Kitchen Range Hood Exhaust Duct		
	1. Where enclosed with 2 hour fire-rated construction by G.C.	---	---
	2. Where not enclosed with 2 hour fire-rated construction by G.C.	FBW	3
G.	Dishwasher Exhaust Duct	---	---

3.8 PIPE INSULATION SCHEDULE:

	PIPE SIZE (Inches)	INSULATION TYPE	THICKNESS (Inches)	JACKET TYPE	
A.	Domestic cold water above grade	All	FPC	½	ASJ*
B.	Domestic cold water below grade	All	---	---	---

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C. Domestic hot water & recirculating above grade	All	FPC	1	ASJ*
D. Domestic hot water & recirculating below grade	All	PFP	1	---
E. Condensate drain piping	All	FPC	1	PVC

*Apply PVC jacket to all insulated piping installed exposed in rooms, freezers and coolers; exception - Mechanical Room 108.

END OF SECTION 23 25 00

SECTION 23 60 00**HEATING EQUIPMENT****PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. This Section includes equipment used for heating throughout the Project.

1.2 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each piece of equipment, clearly indicating what features, options and accessories are being provided.
- B. See Section 23 01 00.

PART 2 - PRODUCTS**2.1 ELECTRIC UNIT HEATERS:**

- A. Shall consist of non-glowing electric heater coils constructed from nickel-chromium resistance wire enclosed in the steel sheath to which steel plate fins are brazed, and UL listed. Heater casings shall be steel construction, powder coated, designed for mounting from ceiling or wall with attached brackets.
- B. Each heater shall be provided with thermal overload protection for the motor, and a separate thermal overload protection for the heater element. Provide with controls transformer and 24 volt wall mounted or unit mounted thermostat, as scheduled. Provide integral disconnect switch.
- C. Motor shall be totally enclosed, permanently lubricated, suitable for use in either horizontal or vertical position.
- D. All heater and control wiring shall terminate in an integral control box.
- E. Acceptable Manufacturers - Berko, Markel, Q-Mark, Raywall/Redd-i.

2.2 ELECTRIC RADIANT COVE HEATER:

- A. Furnish and install Electric Cove Heaters where specified. The heaters shall be constructed of .096" thick Aluminum.

- B. The heater surface shall be concave in contour and saw-tooth in profile. The finish shall be of powder coat white finish.
- C. The heating element shall be of Nichrome wire, embedded in Magnesium Oxide powder, enclosed and sealed in Aluminum metal tubing. The heater shall be listed by ETL and the elements shall be supplied with a one year limited warranty.
- D. Provide line voltage, wall mounted thermostat rated for total circuit load, with positive off position.
- E. Acceptable Manufacturers - Berko, Markel, Q-Mark, Raywall/Redd-i.

PART 3 - EXECUTION

3.1 MANUFACTURER'S DIRECTIONS:

- A. Install equipment in strict accordance with manufacturer's recommendations and of other sections of the Specifications.

END OF SECTION 23 60 00

SECTION 23 65 10 - ROOFTOP HEATING/COOLING UNITS**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Provide labor and equipment, materials and transportation to receive, install and put into operation roof top air conditioning equipment as specified, scheduled, shown, or detailed in the Project Documents.
- B. This Contractor shall be responsible for the complete installation of the control systems for all roof top heating/cooling units specified herein, including all wiring, thermostats and ancillary equipment necessary to provide a complete and fully operative control system as specified or scheduled. Where required by applicable codes, this contractor shall provide the services of a licensed electrician to complete this work. Where indicated on plans, the electrical contractor will provide a empty box and conduit for the thermostat and controls wiring.

1.2 SUBMITTAL DATA:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment. Include:
 - 1. Equipment, piping and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections
 - 2. Piping, valves and fittings shipped loose showing final location in assembly
 - 3. Control equipment shipped loose, showing final location in assembly
 - 4. Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads
 - 5. Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers
 - 6. Fan performance curves
 - 7. Details of vibration isolation
 - 8. Estimate of sound levels to be expected across individual octave bands in db
 - 9. Type of refrigerant used
 - 10. Plan view, front view end view, back view and curb detail with dimensions
 - 11. Quality Assurance:
 - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties
 - b. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements
 - c. Manufacturer's Instructions: Manufacturer's installation instructions
 - 12. Manufacturer's Field Reports: Manufacturer's field reports specified herein
 - 13. Closeout Submittals: Submit the following:

- a. Warranty: Warranty documents specified herein
 - b. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Closeout Submittals (Maintenance Data and Operation Data) Section. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance. Include names and addresses of spare part suppliers
 - c. Provide brief description of unit, with details of function, operation, control and component service
 - d. Provide equipment inspection report and equipment operation test report
- B. See Section 23 01 00.

1.3 REFRIGERANT AND OIL:

- A. Furnish an adequate supply of refrigerant and oil, and maintain refrigerant and oil in the system in proper quantities for one year warranty period from the date of acceptance by the Owner. Any source of leakage necessitating addition of refrigerant or oil during warranty period shall be found and corrected.
- B. Refrigerant or oil lost or contaminated during the warranty period shall be provided without additional charge for both labor and material.

1.4 WARRANTY:

- A. Refrigeration compressors shall be warranted for five years.
- B. Aluminized steel heat exchanger furnace shall carry a 15 year non-prorated warranty.
- C. All other unit components shall be warranted for one year.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONING UNITS:

- A. One-piece, air-to-air, factory assembled, precharged, piped, and wired packaged unit. The manufacturer shall test operate unit at the factory prior to shipment.
- B. Provide leakproof, insulated roof mounting curb approved by the National Roofing Contractor's Association, with built-in cant strip and flashing constructed of 14 gage minimum thickness galvanized steel, 14-inch minimum height, designed to form a waterproof assembly when the unit is installed. Curb shall be full perimeter design with all service connections within the curb area, "structural" type, arranged to span between supports. Top surface shall be level (provide pitched curb when installed on pitched roof). Coordinate roof curb with roof type and slope to ensure compatibility. Provide adaptor curb where required to mount new unit on existing curb.
- C. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
 3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
 4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
 6. Access to filters, dampers, heaters, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
 7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 8. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
- D. Compressor(s) shall be hermetic scroll type, with crankcase heater, vibration isolation, and filter drier(s). Motor compressor units shall be warranted for five years.
1. Compressors shall be refrigerant cooled, resiliently mounted on rubber mounts for vibration isolation, and isolated from condenser and evaporator fan air streams
 2. Refrigerant shall be 410A.
 3. Units with a nominal capacity of 7.5 tons and greater shall be provided with multiple compressors and a separate refrigerant circuit for each compressor.
- E. Coils:
1. Evaporator Coils and hot gas reheat coils shall be aluminum plate fins mechanically bonded to copper tubes, with balanced port thermal expansion valves, freeze protection on each circuit, pressure and leak tested to 500 psi.
 2. Condenser coils shall be aluminum lanced fins thermally bonded to aluminum flat tube.
- F. Supply Fans
1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
 2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

- G. Outdoor air fans shall be direct drive propeller type, with inherent motor protection. See Section 23 01 00 for motors.
- H. Units with gas heat shall have a redundant gas valve to achieve 100% pilot shutoff when there is no call for heat as well as the standard gas valve for controlling the main burner, automatic spark ignition system, limit switch, flame rollout switch, induced draft fan and draft failure switch.
- I. Gas burners shall be aluminized steel. Multicell heat exchangers shall be heavy gage steel. Heat exchangers shall have a 15-year warranty.
- J. Units shall contain the following safety controls-
1. Low and high pressure cutouts on each circuit.
 2. TXV with removable element head on each circuit.
 3. Modulating hot-gas reheat control valve.
 4. Crankcase heater on each compressor.
 5. Compressor motor overloads.
 6. Timer to limit compressor starts to not more than one each 5 minutes (adjustable).
 7. Low ambient control to allow compressor operation to 40°F and to prevent compressor operation below 40°F (adjustable) outside air temperature.
- K. Units shall be factory wired for single point electrical connection.
- L. On units 2,000 to 15,000 cfm, Install a UL approved smoke detector, provided by the electrical contractor or by the unit manufacturer as scheduled, and installed by the mechanical contractor in the return air path, arranged to shut down the unit fan(s) upon detection of smoke. Coordinate installation of the remote test switch, and interface with building fire alarm system, as applicable, with electrical contractor.
- M. Air Filters -
1. Rooftop Air Conditioning Units shall be provided from factory with 2" thick filter frames.
 2. Provide temporary filter elements in the filter banks of supply systems used during construction prior to using the system.
 3. Temporary filter elements may be either throw-away type with frames taped air-tight or as scheduled for the system.
 4. Immediately prior to test and balance operations, replace temporary filters with a new set of scheduled filter elements.
 5. After final acceptance, a new set of scheduled filter elements shall either be delivered to Owner or installed to replace "test" filters, as directed by Owner.
 6. Filter Elements - Type MEPM - medium efficiency pleated media - 2-inch thick disposable type of pre-formed pleated, non-woven, cotton fabric media continuously laminated to a supporting steel wire grid conforming to the configuration of the pleat, sealed in a chip board media frame, minimum 25 percent average NBS efficiency with atmospheric dust. Maximum 0.38-inches WC initial resistance at 500 fpm face velocity. Minimum MERV 7.
- N. Provide each unit with a low leakage, motorized damper. When scheduled, each unit shall be equipped with an economizer package for "free cooling" with outside air. Package shall contain -

1. Low leakage dampers.
 2. Powered exhaust fans.
 3. Spring return damper operators.
 4. Capability of simultaneous economizer cooling and mechanical cooling.
 5. Discharge air sensor and enthalpy changeover for damper control.
 6. Outdoor air thermostat (adjustable) to lock out mechanical cooling when outdoor air temperature is below setpoint.
 7. When scheduled, a field or factory-installed (as scheduled) indoor air quality (carbon dioxide) sensor to adjust damper position proportionally to pollutant level.
 8. Associated controls, related equipment and circuiting.
- O. When scheduled, provide units with:
1. Modulating hot gas reheat capability. Furnish zone humidity sensor with unit.
 2. Additional features as scheduled.
- P. Provide units with factory mounted and wired non-fused power disconnect switch, and factory mounted and wired ground fault interrupting, weatherproof power receptacle with in-use cover. Receptacle shall remain energized when disconnect is turned off.
- Q. Controls:
1. Factory Installed and Factory Provided Controller
 - a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
 - b. Controller shall be capable of stand-alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - d. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
 - e. Provide wall mounted touch screen interface where scheduled.
 - f. With enthalpy activated fully modulating economizer option, an outdoor air humidity sensor shall be factory installed.
 - g. With the modulating hot gas reheat option a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.
 - h. Outside air temperature sensor shall be factory mounted and wired. Supply air temperature sensor shall be furnished with the unit for field installation.
 - i. Shall accept input from a differential pressure sensor
 - j. 2-stage or modulating heat, as scheduled/number of cooling stages as scheduled.
 - k. Indoor air quality input
 2. Room sensors.
 3. Provide additional control accessories where scheduled or where required for the installation.
- R. Acceptable Manufacturers: Aeon, Carrier, Daikin, Greenheck, Lennox, Trane Horizon, Valent, York.

PART 3 - EXECUTION**3.1 MANUFACTURER'S DIRECTIONS:**

- A. Install equipment in strict accordance with manufacturer's recommendations and requirements of other Sections.

3.2 COORDINATION:

- A. Units installed on roof:
 - 1. Roof decking shall remain inside of curb except for openings required for duct, controls and electrical power penetrations. Coordinate roof deck installation and cutting of openings with General Contractor. Pack annular space around duct and conduit penetrations with fiberglass insulation.
 - 2. Coordinate responsibility for providing equipment roof curbs and flashings with roofing contractor. Coordinate curb type with roofing contractor to ensure curb's compatibility with roofing system and with curb-mounted equipment.
 - 3. Coordinate electrical installation with electrical contractor so that all required conduit roof penetrations occur within the unit curb.
- B. Units installed on grade:
 - 1. Coordinate concrete slab installation with General Contractor.
 - 2. Install roof curb level and secured to concrete slab.
 - 3. Provide sheet metal shroud as detailed on drawings, for all ductwork exposed outside of the building.
- C. Electrical Connections:
 - 1. Coordinate with other trades the complete electrical installation for all necessary final power and controls connections to equipment and loose shipped electrical components.
 - 2. For rooftop installation, coordinate electrical installation with electrical contractor so that all required conduit roof penetrations occur within the unit curb.

3.3 DELIVERY, STORAGE AND HANDLING:

- A. Handle rooftop units and components carefully to prevent damage. Replace damaged rooftop units or components with new.
- B. Store rooftop units and components in clean dry place, off the ground and protect from weather, water, and physical damage.
- C. Rig rooftop units to comply with manufacturer's rigging and installation instructions for unloading rooftop units and moving them to final location.

3.4 EXAMINATION:

- A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.5 INSTALLATION:

- A. General: Install rooftop units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

3.6 DEMONSTRATION:

- A. Start-up Services: Provide the services of a factory authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.7 TESTING AND BALANCING:

- A. See Section 23 99 00.

3.8 SYSTEM VERIFICATION AND CALIBRATION:

- A. Make all repairs, adjustments and programming changes necessary to accomplish the desired operation of the HVAC systems.
- B. See MECHANICAL SYSTEM VERIFICATION AND CALIBRATION of Specification Section 23 01 00 for complete requirements.

END OF SECTION 23 65 10

SECTION 23 65 75 – ROOFTOP HEATING ONLY OUTSIDE AIR SUPPLY UNITS**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Provide labor and equipment, materials and transportation to receive, install and put into operation complete rooftop outside air supply unit(s) as specified, scheduled, shown, detailed or implied in the Project Documents.
- B. Provide accessories required for the equipment to function properly and safely for the service intended.

1.2 QUALITY ASSURANCE:

- A. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

1.3 SUBMITTAL DATA:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment.
- B. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- C. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- D. See Section 23 01 00.

1.4 WARRANTY:

- A. Heat exchangers shall be warranted for 25 years.
- B. All other unit components shall be warranted for one year.

PART 2 - PRODUCTS**2.1 PACKAGED ROOFTOP OUTSIDE AIR SUPPLY UNIT:**

- A. One-piece, air-to-air, factory assembled, and wired packaged unit. The manufacturer shall test operate unit at the factory prior to shipment. Startup and initial operational testing shall be provided by manufacturer factory certified representatives.
- B. Provide leakproof, insulated roof mounting curb approved by the National Roofing Contractor's Association, with built-in cant strip and flashing constructed of 14 gage minimum thickness galvanized steel, 24-inch minimum height, designed to form a waterproof assembly when the unit is installed. Curb shall be full perimeter design with all service connections within the curb area, "structural" type, arranged to span between supports. Top surface shall be level (provide pitched curb when installed on pitched roof). Coordinate roof curb with roof type and slope to ensure compatibility. Provide adaptor curb where required to mount new unit on existing curb.
- C. On units 2,000 to 15,000 cfm, Install a UL approved smoke detector, provided by the electrical contractor, installed by the mechanical contractor in the return air path, arranged to shut down the unit fan(s) upon detection of smoke. Coordinate interface with building fire alarm system with electrical contractor.
- D. General Description
 - 1. Packaged rooftop unit shall include filters, supply fans, dampers, gas heaters, and unit controls.
 - 2. Unit shall be factory assembled and tested including run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
 - 3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - 4. Unit components shall be labeled, including pipe stub outs and electrical and controls components.
 - 5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
 - 6. Installation, Operation and Maintenance manual shall be supplied within the unit.
 - 7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
 - 8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
- E. Construction
 - 1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, heaters, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
9. Unit shall include lifting lugs on the top of the unit.

F. Electrical

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
2. Unit shall be provided with factory mounted and wired ground fault interrupting, weatherproof power receptacle with in-use cover. Receptacle shall remain energized when disconnect is turned off.

G. Supply Fans

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

H. Gas Heating

1. Unit shall include a natural gas furnace with modulating capacity.
2. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty.
3. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.

4. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
5. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
6. Natural gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. 90 Mbtu/h, 150 MBtu/h, 195 MBtu/h, 210 MBtu/h, 270 MBtu/h, 292.5 MBtu/h, 390 MBtu/h, and 540 MBtu/h gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity. 405 MBtu/h and 810 MBtu/h gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity. 1080 MBtu/h gas heating assembly shall be capable of operating at any firing rate between 100% and 15% of its rated capacity.

I. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8.

J. Outside Air/Economizer

1. Unit shall include 100% motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return, 2 position actuator. Unit shall include outside air opening bird screen and outside air hood with rain lip.

K. Controls

1. Temperature sensors - for the system provide temperature sensors as shown on plans and controls to run fan continuously during occupied signal from lighting controller, or manual override, and cycle heating to maintain discharge air temperature and satisfy room temperature sensors based on an averaging of signals from the room temperature sensors.
2. Provide additional control accessories where scheduled or where required for the installation.

L. Acceptable Manufacturers – Aeon, Carrier, Daiken, Greenheck, Lennox, Trane Horizon, Valent, York.

PART 3 - EXECUTION**3.1 MANUFACTURER'S DIRECTIONS:**

- A. Install equipment in strict accordance with manufacturer's recommendations and requirements of other Sections.

3.2 COORDINATION:°

- A. Units installed on roof:
 - 1. Roof decking shall remain inside of curb except for openings required for duct, controls and electrical power penetrations. Coordinate roof deck installation and cutting of openings with General Contractor. Pack annular space around duct and conduit penetrations with fiberglass insulation.
 - 2. Coordinate responsibility for providing equipment roof curbs and flashings with roofing contractor. Coordinate curb type with roofing contractor to ensure curb's compatibility with roofing system and with curb-mounted equipment.
 - 3. Coordinate electrical installation with electrical contractor so that all required conduit roof penetrations occur within the unit curb.
- B. Units installed on grade:
 - 1. Coordinate concrete slab installation with General Contractor.
 - 2. Install roof curb level and secured to concrete slab.
 - 3. Provide sheet metal shroud as detailed on drawings, for all ductwork exposed outside of the building.
- C. Electrical Connections:
 - 1. Coordinate with other trades the complete electrical installation for all necessary final power and controls connections to equipment and loose shipped electrical components.
 - 2. For rooftop installation, coordinate electrical installation with electrical contractor so that all required conduit roof penetrations occur within the unit curb.

3.3 DELIVERY, STORAGE AND HANDLING:

- A. Handle rooftop units and components carefully to prevent damage. Replace damaged rooftop units or components with new.
- B. Store rooftop units and components in clean dry place, off the ground and protect from weather, water, and physical damage.
- C. Rig rooftop units to comply with manufacturer's rigging and installation instructions for unloading rooftop units and moving them to final location.

3.4 EXAMINATION:

- A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.5 INSTALLATION:

- A. General: Install rooftop units in accordance with manufacturer's installation instruction. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

3.6 DEMONSTRATION:

- A. Start-up Services: Provide the services of a factory authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.7 TESTING AND BALANCING:

- A. See Section 23 99 00.

3.8 SYSTEM VERIFICATION AND CALIBRATION:

- A. Provide attendance by a factory authorized service representative to work in cooperation with other participants to calibrate, integrate, and verify operation of all components and equipment described in this work.
 - 1. Make all repairs, adjustments and programming changes necessary to accomplish the desired operation of the HVAC systems.
 - 2. See MECHANICAL SYSTEM VERIFICATION AND CALIBRATION of Specification Section 23 01 00 for complete requirements.

END OF SECTION 23 65 75

SECTION 23 80 00 - HVAC EQUIPMENT - AIR SIDE

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install air-side heating, ventilating and air handling equipment of all types employed in the Project.

1.2 QUALITY ASSURANCE

- A. ISO 9001 Certification
- B. Unit designed and tested in compliance with ARI 430 air delivery ratings per ARI 430-1999.
- C. Unit designed and tested in compliance with ARI 260-2001.

1.3 REGULATORY REQUIREMENTS

- A. Unit shall be manufactured to conform to UL 1995 Standard and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to unit.

1.4 SUBMITTALS

- A. Submit unit performance data including: capacity, nominal and operating performance.
- B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.
- C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
- D. Provide fan curves with specified operating point clearly plotted.
- E. Submit data on electrical requirements. Include safety and start-up instructions.
- F. See Section 23 01 00.

PART 2 - PRODUCTS

2.1 KITCHEN HOOD SUPPLY AND EXHAUST UNITS:

- A. The unit shall be factory assembled as a unit to include a upblast centrifugal exhaust fan and a direct fired make-up air unit mounted on a single or multiple roof curb(s) as indicated on plans, unit wiring and controls as described herein and as scheduled.
- B. Centrifugal Up-blast Exhaust Fan - as specified below.
- C. Makeup Air Handling Unit -
1. Unit casing shall be of minimum 18 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated. All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
 2. Units shall be provided with access doors sized and located to provide easy access to all components requiring service including fans and motors, filters, dampers and operators, heating sections and controls. Provide lift out access doors, secured with two or more camlock fasteners.
 3. Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.
 4. All units shall be internally insulated with 1" thick 1 1/2 lb./cu.ft. density, neoprene coated fiberglass thermal insulation secured to metal panels with a fire retardant adhesive and welded steel pins at 16" o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges.
 5. Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, and more specifically includes:
 - a. Louvers or hoods on air intakes and exhaust openings with 1" galvanized inlet screens.
 - b. All joints caulked with a water resistant sealant.
 6. Provide insulated, full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 12 inches high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" upturn on inner perimeter, to provide a complete seal against the elements.
 7. Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating. Single low pressure forward curved fans of 18" or less diameter, shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets. All other forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame. V-belt drives shall be furnished with variable sheave on the motor. Motor mounting shall be adjustable to allow for variations in belt tension. Fan- motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel

channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type. Fans shall be attached to the discharge panel by a heavy glass fabric, neoprene impregnated, with a double locking fabric to metal connection. Fan motors shall be totally enclosed TEFC type. See Section 23 01 00 for motors.

8. Make-up air units shall have a direct fired heating section that is labeled by an approved testing agency and approved for both sea level and high altitude areas. Burner assembly shall be a line type capable of modulating turn down ratio of 25:1. The assembly shall be constructed in a draw through arrangement. Outside air is drawn across the burner section at a constant velocity, within the allowable limits of the burner design. Burner assembly and piping to include modulating flow ratio valve, fail-safe shut off valve(s), main and pilot pressure regulators, manual shut off valves and electric pilot valve. Flame surveillance shall be with a solid state programmed flame relay complete with flame rod. The gas train shall be in a cabinet enclosure. Insulation on indoor units shall be 1" thick 1-1/2 lb./cu.ft. neoprene faced on inlet section. Outdoor units shall utilize foil faced insulation downstream of profile plate in addition to neoprene faced insulation in inlet section. Unit shall be rated for natural gas or propane, as scheduled. Provide gas pressure regulator to operate unit at scheduled inlet gas pressure.
9. Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side. Provide unit with 1" permanent washable filters: Fibrous media, neoprene coated and fully fire resistant, encased in a galvanized metal U channel frame, with expanded metal lath each side.
10. Damper frames shall be hat-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2" high grade carbon steel, cadmium plated, shall turn in bronze bushings, fabricated from self-oiling bronze. Rods shall be secured to the blade by means of straps and set screws. Blades shall be 18 gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 48 inches. Damper linkage brackets shall be 16 gauge cadmium plated steel with bronze bushings, and shall be self aligning to prevent binding. Damper blade ends shall be sealed with an adhesive backed foamed polyurethane gasketing. Damper blades exposed to outside air shall be sealed with an adhesive backed foamed polyurethane gasketing on all interlocking edges.
11. Pre-Wiring: Air handling units shall be factory wired and tested, and shall be certified by an approved testing agency using UL approved components. Provide a unit mounted control panel including a master disconnect switch with fuse blocks, sized to handle switching of electrical power to the entire unit, all necessary terminal blocks, motor starters with thermal overloads and manual reset, contactors, motor overload protection, grounding lugs, fused 120 volt control transformer, and all required auxiliary contactors and terminals for the connection of external control devices or relays. Wiring shall be complete, requiring two point field connection; one line voltage power connection and one low voltage controls connection. Wiring shall be in accordance with the pertinent sections of latest edition of the National Electrical Code (ANSI / NFPA 70) pertaining to specific equipment type and purpose. All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function. Prewired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the latest edition of the National Electrical Code (ANSI / NFPA 70).
12. Heater Controls: Gas fired units shall include high limit and combustion air flow switch. Automatic controls shall be housed in a control panel mounted in or on the air handling

unit, which will meet the NEMA standard of the specific installation. Unit shall start from exhaust system interlock to remote panel field-wired to unit control terminal strip. Provide a step-down control transformer to provide 110 volt power to control circuit.

- a. Unit discharge air temperature shall be maintained constant by a discharge air sensor which shall modulate the main flow ratio gas valve. An electronic sensor shall modulate the gas valve through an amplifier. An electronic temperature selector mounted in remote panel shall be capable of adjusting the discharge air temperature setpoint.
 - b. Provide a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.
 - c. Provide for each air handling unit a surface-mounted, control panel with stainless steel enclosure, for the purpose of switching and visual indication of operations. Each panel shall be mounted on the front of its respective exhaust hood (field verify location with Architect) and shall include the following items:
 - 1) Engraved lamicoid labels for each switch/light.
 - 2) Fan ON-OFF switch and light.
 - 3) Heat ON-OFF switch and light.
 - 4) Clogged filter light.
 - 5) Electronic temperature selector.
 - 6) Two (2) fan start/stop relays controlled by the fire protection signal contacts with power supply (only applies to hoods with fire suppression systems).
- D. Acceptable Manufacturer – Absolut Aire, Applied Air, Carnes/SunAir, Duo-Aire, Engineered Air, Greenheck, Sterling.

2.2 CENTRIFUGAL WALL FANS:

- A. Exhaust fans shall be centrifugal wheel, wall ventilators, capacities, sizes, types and accessories as scheduled. Fans scheduled for commercial kitchen hood exhaust shall be UL/cUL 762 listed.
- B. Each fan shall be selected to operate quietly and efficiently on its volume-pressure curve, free from objectionable vibration, and shall carry the certified rating seal authorized by AMCA at the scheduled ratings.
- C. The wheel and spun inlet venturi shall be a centrifugal design of non-sparking construction. Fan wheel shall be backwardly inclined, non-overloading type, constructed of not less than 12 gage aluminum for blades and bottom inlet of wheel and 1/8-inch aluminum for the top plate.
- D. Motor and drive compartment shall be separated from the air stream. Air for cooling the motor shall be supplied to the internal motor compartment through a vent tube from a location free from discharge contaminants.
- E. Outer shroud shall have a rolled bead for added strength.
- F. Drives for fan wheels shall be direct or V-belt as scheduled.
- G. Where required, bearings shall be flanged type, mounted in rubber, sealed and prelubricated.

- H. V-belt drives shall be furnished with variable pitch sheave on the motor.
 - 1. Motor base shall be adjustable.
- I. Motors shall be NEMA standard, resilient mounted, ball bearing, open type with horsepower, speed and current characteristics as scheduled. Furnish with each motor, a factory mounted disconnect switch with motor overload protection suitable for the motor scheduled and factory isolated conduit from the motor compartment to inside the curb cap.
- J. Each unit shall be furnished with an easily removable galvanized or polyvinyl coated steel hardware cloth birdscreen and a gravity backdraft damper. Damper shall be constructed of not less than .020 aluminum formed for rigidity and pivoted to an extruded aluminum or heavy rustproofed steel frame with nylon or brass bearings. Blades shall be connected together with pivoted aluminum tie rods.
- K. Acceptable Manufacturers - Acme, Carnes, Cook, Greenheck.

2.3 LOUVERS (FIXED):

- A. Louvers equivalent to Greenheck model ESD-435 drainable type, fabricated from 6063T5 aluminum extrusions of 0.081 in nominal wall thickness. Blades shall be positioned at 35 deg angles approximately on 4 in centers. Each louver shall be equipped with a framed, removable, rear-mounted screen of 0.75 in x 0.051 in expanded, flattened aluminum.
- B. Louvers shall be stationary type with drainable blades in a 4 in louver frame. Each stationary blade shall incorporate an integral drain gutter and each jamb shall incorporate an integral downspout so water drains to blade end} then down the downspouts and out at the louver sill rather than cascading from blade to blade.
- C. Each factory-assembled louver section shall be designed to withstand wind loadings of 25 PSF (100.0 MPH wind equivalent). Louver frames, mullions, and section joints shall be adequately supported from the building structure to withstand this same wind loading.
- D. Louver performance data shall be licensed under the AMCA Certified Ratings Program and shall bear the AMCA Certified Ratings Seal. This certified performance data shall include airflow pressure loss and water penetration, and shall demonstrate performance equal to or better than the Greenheck model specified.
- E. Louvers shall be supplied with a baked enamel finish applied after a thorough cleaning and preparation of the metal surface. A total dry film thickness of approximately 1.2 mils shall be provided. Color shall be as selected by the Architect from standard color chart.
- F. Acceptable Manufacturers: Air Balance, American Warming & Ventilating, Carnes, Greenheck, Nailor, Ruskin.

2.4 PACKAGED CEILING FANS:

- A. Packaged ceiling fans shall be factory assembled units including fan, motor, housing, prewired plug disconnect and discharge damper with capacities, arrangements and accessories as scheduled. Provide intake grille when installed in ceiling.
- B. Fan wheels shall be of the centrifugal type, direct connected to a permanently lubricated, radio shielded, thermally protected motor with neoprene torsion mounts to isolate vibration.
- C. Fan and motor shall be enclosed in a baked enamel steel housing suitable for horizontal or vertical discharge and ceiling or in-line installation. Housing shall be lined with 1/2-inch acoustical insulation.
- D. Intake grille (where required) shall be white aluminum or plastic and shall be removable for cleaning or service.
- E. Furnish necessary ductwork, transitions, eaves, wall or roof caps as scheduled and as required.
- F. Acceptable Manufacturers, - Acme, Carnes, Cook, Greenheck, Loren Cook, Penn.

2.5 CENTRIFUGAL UP-BLAST ROOFTOP EXHAUST FANS:

- A. Exhaust fans shall be centrifugal wheel, upblast roof ventilators, capacities, sizes, types, and accessories as scheduled.
- B. Each fan shall be selected to operate quietly and efficiently on its volume-pressure curve, free from objectionable vibration, and shall carry the certified rating seal authorized by AMCA at the scheduled ratings.
- C. Square curb base and throat section shall be constructed in one piece, on not less than 12 gage aluminum, with the throat section spun to provide streamlined entrance to the fan wheel. Fan wheel shall be centrifugal, backwardly inclined, non- overloading type, constructed of not less than 12 gage aluminum for blades and bottom inlet of wheel and 1/8-inch aluminum for the top plate.
- D. The fan shall have an upblast arrangement on the discharge with complete grease and condensate drainage. Motor and drive compartment shall be separated from the air stream. Air for cooling the motor shall be supplied to the internal motor compartment through a vent tube from a location free of discharge contaminants.
- E. Outer baffle and motor compartment hood shall be spun aluminum of not less than 12 gage, designed for sub-assembly and arranged for access to motor-drive compartment and wheel assembly without dismantling unit.
- F. Drives for fan wheels shall be direct or V-belt as scheduled.
- G. Supporting members of drive assembly shall be constructed of not less than 1/8-inch aluminum, isolated with multi- directional vibration mountings.
- H. Where required, bearings shall be flanged type, mounted in rubber, sealed and prelubricated.

- I. V-belt drives shall be furnished with variable sheave on the motor.
- J. Motor base shall be adjustable.
- K. Motors shall be resilient mounted, ball bearing, open type with horsepower, speed and current characteristics as scheduled. See Section 23 01 00 for motors. Furnish with each motor, a factory mounted disconnect switch with motor overload protection suitable for the motor scheduled and factory isolated conduit from the motor compartment to inside the curb cap.
- L. Each unit (except kitchen hood exhaust fans) shall be furnished with an easily removable galvanized or polyvinyl coated steel hardware cloth birdscreen and a gravity backdraft damper. Damper shall be constructed of not less than .020 aluminum formed for rigidity and pivoted to an extruded aluminum or heavy rustproofed steel frame with nylon or brass bearings. Blades shall be connected together with pivoted aluminum tie rods.
- M. Provide fan manufacturer's prefabricated minimum 24-inch high insulated metal roof curbs constructed of heavy galvanized steel or welded aluminum to match fan construction, full 2-inch thick heavy density internal insulation, rubber curb cap for fan base mounting, factory clips or attachment devices to secure fan tight to curb, counterflashing, wide roof flange, backdraft damper frame, and cant strip. Furnish complete and as recommended by the manufacturer.
- N. Acceptable Manufacturers - Acme, Ammerman, Carnes, Greenheck, Loren Cook, Jenn-Air, Penn, Twin City Fans.

2.6 TYPE I KITCHEN HOODS:

- A. Kitchen ventilation hood shall be of the full canopy type. When scheduled, provide with rear supply air plenum to supply make-up air to the hood in a manner that does not interfere with the cooking operations beneath the hood(s).
- B. The hood(s) shall be constructed of a minimum of 18 gauge stainless steel construction. Hoods shall be constructed using the standing seam method for optimum strength. The seams on the canopy shall be welded liquidtight, and all exposed external welds shall be ground and polished to match the original finish of the metal. Lighter material gauges, alternate material types and finishes (400 series stainless steel, cold rolled steel, etc.) and non-liquidtight welding (tack weld, spot weld, etc.) is not acceptable. Construction shall include corrosion-resistant steel framing members for strength. All unexposed interior surfaces shall be constructed of a minimum 18 gauge corrosion-resistant steel, including but not limited to ducts, plenum, framing and brackets.
- C. Hood(s) shall include a filter housing constructed of the same material as the hood. Filters shall be (aluminum, U.L. Classified, and in sufficient numbers and sizes to ensure optimum performance as specified by the filter manufacturer. The filter housing shall terminate in a pitched, full length, grease trough which shall drain into a removable grease drawer.
- D. Vaporproof, U.L. Listed light fixtures shall be prewired to a junction box situated at the top of the hood for field connection. Wiring shall conform to the requirements of the 2000 National Electrical Code.

- E. The hood(s) shall be constructed as U.L. Listed (with Fire Damper type canopies and built in accordance with National Fire Protection Association (NFPA) Bulletin #96, Building Officials and Code Administrators (BOCA), and bear the National Sanitation Foundation (NSF) Seal of Approval.
- F. Fire Suppression System
1. Provide an Ansul or approved equal, R102 liquid fire suppression system for the range hood.
 2. Provide with control panel, manual pull station, piping, nozzles, cables and other required equipment necessary for a complete operable system in accordance with NFPA-17A and NFPA-96. Coordinate with electric gas solenoid valve provided by plumbing contractor. Control panel shall have a minimum of two spare sets of form C, dry contacts to indicate activation of the hood fire protection system and to control fan start/stop relays.
 3. Piping shall be run unexposed where possible. All exposed piping shall be encased in stainless steel or chrome plated steel pipe shall be used.
- G. Controls
- a. Provide the kitchen hood with a surface-mounted, control panel with stainless steel enclosure, for the purpose of switching and visual indication of operations. Each panel shall be mounted on the front of its respective exhaust hood (field verify location with Architect) and shall include the following items:
 - 1) Engraved lamicoïd labels for each switch/light.
 - 2) Fan ON-OFF switch and light.
 - 3) Hood light Switch (20A, 125VAC toggle type).
 - 4) One (1) fan start/stop relays controlled by the fire protection signal contacts with power supply (only applies to hoods with fire suppression systems).
 - 5) One (1) relay controlled by fire protection signal contacts to operate shunt trip circuit breakers (only applies to hoods with fire suppression systems).
 - 6) One (1) relay for interface with building control system to signal when exhaust is running.
 - 7) One (1) spare relay for incidental equipment and systems associated with hood safety operation.
- H. Acceptable Manufacturers - Captive Air, Custom Aire, Duo-Aire, Econovent, Greenheck

2.7 TYPE II KITCHEN HOODS:

- A. The hood(s) shall be designed for fume ventilation applications over non-grease producing equipment. Hood(s) shall be constructed of a minimum of 18 gauge galvanized steel construction. The seams on the canopy shall be welded liquidtight, and all exposed external welds shall be ground and polished to match the original finish of the metal. Lighter material gauges, alternate material types and finishes (400 series stainless steel, cold rolled steel, etc.) and non- liquidtight welding (tack weld, spot weld, etc.) is not acceptable. Construction shall include corrosion-resistant steel framing members for strength. All unexposed interior surfaces shall be constructed of a minimum 18 gauge corrosion- resistant steel, including but not limited to ducts, plenum, framing and brackets.
- B. The hood(s) shall be fabricated in accordance with National Fire Protection Association (NFPA) Bulletin #96, and shall bear the National Sanitation Foundation (NSF) Seal of Approval.

- C. Acceptable Manufacturers - Captive Air, Custom Aire, Duo-Aire, Econovent, Greenheck.

2.8 AIR CURTAINS:

- A. Packaged air curtains shall be factory assembled units including a stainless steel casing, centrifugal fans, raised stainless steel inlet screen, discharge nozzle, motor(s), and cleanable filter, fan, with capacities, arrangements and accessories as scheduled.
- B. The air curtain unit shall provide a specific CFM and a uniform velocity across the entire length of the discharge nozzle area.
- C. Units shall be furnished in single increments of sufficient structural strength to be supported from both ends without intermediate support. Multiple units shall not be permitted. Unit casing shall be a minimum of 18 gauge 304 stainless steel in a number three finish.
- D. Motor Type: Open Drip Proof (ODP), multi-speed, resiliently mounted, continuous duty, air over with integral thermal-overload protection.
1. Bearings: Heavy duty type permanently lubricated, shielded ball bearings of equal size.
- E. Galvanized fans shall be forward curved centrifugal type, double inlet design, with zinc plated hubs. Tangential type blowers, belt drives, and coupling connection shall not be permitted.
- F. Inlet screen shall be perforated stainless steel powder coated black.
- G. Discharge nozzle shall be high efficiency discharge plenum. Air curtain creates a positive air seal with directional air foil vane. The vane shall facilitate a deflection of the air stream by +/- 20 degrees.
- H. Electric Heat:
1. Factory mounted electric heating elements. The heater shall consist of factory wired heating coil.
 2. Heating elements shall be mounted inside the air curtain plenum on the discharge side of the blowers.
 3. Heating Element: Helical coil with point suspension of elements.
 4. Power Supply: Single point [multi-point] power connection and control wiring to the air curtain.
 5. Heater Casing: Galvanized steel.
 6. Protection: Automatic reset thermal overloads and contactor interlock.
 7. Provide low voltage, remote mounted thermostat.
- I. Provide accessories as scheduled and as required for installation.
- J. Complete Air Curtain unit shall be ETL or UL listed, for the United States and Canada. When unit(s) will be mounted outdoors, unit(s) must bear ETL or UL label for outdoor use.
- K. Unit shall be built to USDA and FDA compliance.
- L. Acceptable Manufacturers: Mars, Powered Aire, Inc.

2.9 BACKDRAFT DAMPERS:

- A. See Section 23 85 00.

2.10 EQUIPMENT MOTORS AND BEARINGS:

- A. See Section 23 01 00.

PART 3 - EXECUTION**3.1 EQUIPMENT INSTALLATION:**

- A. Install equipment in strict accordance with manufacturer's recommendations and requirements of other sections.

3.2 SPACE REQUIREMENTS:

- A. The Contractor shall field measure all existing clearances relative to receiving, transporting and installing equipment where indicated on the drawings. If necessary, the contractor shall disassemble unit and reassemble in final installed position. Such disassembly and reassembly shall be approved by and carefully coordinated with the equipment manufacturer.

3.3 DELIVERY, STORAGE, AND HANDLING:

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags on each section to indicate location and orientation in direction of airflow. Each section shall have lifting points to allow for field rigging and final placement of section.
- C. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- D. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units. If these components are not completely assembled, contractor shall be responsible for all expenses associated with installation, testing, and vibration balancing of fan(s).

3.4 START-UP AND OPERATING REQUIREMENTS:

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

3.5 SYSTEM VERIFICATION AND CALIBRATION:

- A. See Section 23 01 00.

3.6 TEST AND BALANCE:

- A. See Section 23 99 00.

END OF SECTION 23 80 00

SECTION 23 85 00 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all necessary labor, equipment, and materials for a complete duct system, including all hardware and accessory devices.
- B. Install instrumentation devices in the duct system, furnished under Section 23 90 00.

1.2 STANDARDS:

- A. Ductwork shall be fabricated, erected and installed and fitted out with accessories in accordance with current editions of the following -
 - 1. Governing Building Codes.
 - 2. NFPA 90A.
 - 3. SMACNA HVAC Duct Construction Standards.

1.3 DEFINITIONS:

- A. Pressure - Velocity Classification - classifications of duct construction as defined in SMACNA HVAC Duct Construction Standards, First Edition, 1985 (Table 1-1).
- B. Insulated Ductwork - externally insulated as specified in Section 23 25 00.
- C. Preinsulated Ductwork - ductwork constructed of insulating material or incorporating insulating material during fabrication.

1.4 SUBMITTALS:

- A. Submit complete printed catalog and descriptive data for each major piece of equipment, clearly indicating exactly what features, options and accessories are being provided.
- B. See Section 23 01 00.

1.5 OPTIONS:

- A. Equivalent area round ducts may be substituted for rectangular ducts serving a single outlet provided the round duct tap is made into the rectangular with a round take-off fitting with integral volume damper as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Galvanized steel sheets, lock-forming quality, ASTM A-525 with galvanized coating for both sides of the sheet.
- B. Black steel sheets - conforming to ASTM A-366.
- C. Aluminum base alloy sheets - conforming to ASTM B-209.
- D. Proprietary Flanged Transverse Duct Joint Assembly - Ductmate system, applied and installed in accordance with manufacturer's published recommendations.
- E. Duct Sealant - United, Foster, Hardcast, Minnesota Mining Manufacturing.

2.2 FLEXIBLE CONNECTIONS:

- A. Woven nylon, 22 oz./sq. yd., 150 lb. tongue tear strength, 500 lb. tensile strength, flame retardant coating, proof fabric maximum 10-inches long, minimum 4-inches in direction of air flow.
- B. Acceptable Manufacturers – Ductmate, Durodyne, Hardcast, Ventfabrics.

2.3 MOTORIZED DAMPERS:

- A. Louver type with not less than 16 gauge welded steel frames and galvanized finish. Blades shall have interlocking edges, vinyl or neoprene gaskets, and Teflon coated stainless steel thrust washers. Blades shall be edged with neoprene.
- B. Actuators shall be driven by electrically powered motors and shall be sized to operate their appropriate dampers or valves with sufficient reserve power to provide 2-position action. Provide adjustable positive stops or limit switches on each actuator.
- C. Acceptable Manufacturers - Air Balance, Carnes, Empco, Greenheck, Krueger, Louvers & Dampers, Ruskin.

2.4 BACKDRAFT DAMPERS:

- A. Provide heavy-duty shutter type dampers, with galvanized 16 gage or extruded aluminum frame and wind stops, minimum 28 gage galvanized steel or 26 gage aluminum blades, 3/16-inch steel shaft with "Oilite" bronze bearings, roll formed blade edged with felt sealer, blades linked with tie bar and adjustable counter weight, to allow full blade position parallel to air flow under full air flow with gravity closing of dampers on reverse flow.
- B. Provide frames for required mounting and access doors required for complete adjustment of balance weight.
- C. Fan manufacturer's backdraft dampers are acceptable where furnished and installed in conjunction with exhaust fan installations scheduled, and similar to above.

- D. Acceptable Manufacturers - Air Balance, Carnes, Empco, Greenheck, Krueger, Louvers & Dampers, Ruskin.

2.5 VOLUME DAMPERS:

- A. Provide manual balancing dampers with position locking mechanism as shown and as required to balance the air flow to each outlet or from each inlet.
- B. Construction in accordance with SMACNA manuals.

2.6 PRE-INSULATED, CLOSED CELL, OUTDOOR DUCTWORK:

- A. Constructed per requirements for the 2" water gage pressure class minimum, positive or negative as applicable, and SMACNA seal class 3 or less.
- B. Compliance:
1. Inner liner shall comply with the requirements of UL (C-UL) 181, ASTM E2257, ASTM E84, ASTM C423, ASTM E96/E96M procedure A for permeability, ASTM C1071, ASTM C518, UL 723, NFPA 90A, NFPA 90B, NFPA 255.
 2. Outer cladding shall comply with the requirements of 1. UL-94 Flammability V-0, ASTM D-638 Tensile Strength of 6250 psi, ASTM D-790 Flexible Strength of 11,000 psi, ASTM D-4226 Drop Impact Resistance, ASTM D-4216 Cell Classification.
- C. The inner liner shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied .001" (25 micron) aluminum foil facing reinforced with a fiberglass scrim. An added UV stable, IR reflective 1000-micron high impact resistant titanium infused vinyl is factory bonded using a full lamination process. The lamination process shall permanently bond the vinyl clad to the outer surfaces of the phenolic foam panel to provide a zero-permeability water tight barrier and to form a structurally insulated panel (SIP) in which to form duct segments. Processes that do not employ a full lamination process are not acceptable. Self-applied adhesives such as tapes, caulks or cladding that incorporate pressure sensitive or spray adhesives are not acceptable.
1. The thermal conductivity shall be no greater than 0.13BTU • in/Hr •ft²•°F.
 2. The density of the foam shall not be less than 3.5 pcf with a minimum compressive strength of 28 psi.
 - a. Maximum Temperature: Continuous rating of 185 degrees F inside ducts or ambient temperature surrounding ducts.
 - b. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - c. Permeability: 0.00 perms maximum when tested according to ASTM E 96/E 96M, Procedure A.
 - d. Antimicrobial Agent: Additive for antimicrobial shall not be used but instead, raw product must pass UL bacteria growth testing.
 - e. Noise-Reduction Coefficient: 0.05 minimum when tested according to ASTM C 423, Mounting A.
 - f. Required Markings: All interior duct liner shall bear UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for internal closure materials.
 - g. All insulation materials shall be closed cell with a closed cell content of >90%.

- h. R-value:
 - 1) 2 1/16" Double wall (55 mm): 14.1 R

- D. Closure Materials:
 - 1. V-Groove Adhesive: Silicone (interior only).
 - 2. UV stable 1000 micron high impact resistant titanium infused vinyl (exterior).
 - a. Factory manufactured seamless corners for zero perms.
 - b. Cohesive bonded over-lap at corner seam covers for zero perms.
 - c. Water resistant titanium infused welded vinyl seams.
 - d. Mold and mildew resistant.
 - 3. Polymeric Sealing System:
 - a. Structural Membrane: Aluminum scrim with woven glass fiber with UV stable vinyl clad applied
 - b. Minimum Seam Cover Width: 2 7/8" inches (75 mm)
 - c. Sealant: Low VOC.
 - d. Color: White (colors, matched by architect optional).
 - e. Water resistant.
 - f. Mold and mildew resistant.
 - 4. Duct Connectors.
 - a. Factory manufactured cohesive bonded strips (low pressure only).
 - b. Factory manufactured all aluminum grip flange.
 - 1) Grip flange
 - 2) F-flange
 - 3) H-flange
 - 4) U-flange
 - c. Factory manufactured galvanized 4-bolt flange.

- E. Outdoor Cladding
 - 1. Duct segments shall incorporate UV stable 1000 micron high impact resistant titanium infused vinyl which is introduced during the manufacturing process.

- F. Flange coverings
 - 1. Flanges shall be field-sealed airtight before flange covers are installed. Flange covering consists of the following:
 - a. Foam tape insulation with molded 39 mil covers.
 - b. Air gap (heating only application) with molded 39 mil covers.

- G. Reinforcement
 - 1. The duct system shall provide designed and built with adequate reinforcement to both; withstand air pressure forces from within the duct from blower pressure and shall be built to handle expected snow load for the location where the duct is being installed. The duct system will employ Airtruss™ reinforcement system when both specified static pressure and duct sizes dictate the need. This is a factory installed system and no field installation of the reinforcement system is required.

- H. Weight
 - 1. The duct system shall provide low weight stresses on the building framing and support members. Assembled duct shall have a weight of 0.86 lbs. per square foot to maximum weight of 2.7 lbs. per square foot (depending on R-value and reinforcement requirement). Hangers and tie-downs are to be detailed on the manufacturer's installing contractors

detail drawings prior to installation but not exceeding 13' for duct girth <84" and 8' for duct girth >85" between hangers and designed to carry the weight and wind load of the ductwork.

- I. Equivalent to Kingspan, Therma duct.

2.7 FLEXIBLE DUCT:

- A. Flexible duct shall be light weight duct formed with a resilient core of continuous, chlorinated polyethylene inner air barrier and insulated with resilient 1 1/2-inch thick fiberglass and jacketed with a tough scrim-reinforced aluminum vapor barrier and containing a totally encapsulated reinforcing wire helix.
- B. Listed as UL 181, Class 1 duct. Complies with NFPA 90A.
- C. Provide flexible duct clamps of self-locking nylon, or stainless steel with swivel action screw.
- D. Acceptable Manufacturers - Flexmaster, Thermaflex.

2.8 BRANCH DUCT TAKE-OFF:

- A. A round or rectangular take-off made from a rectangular supply, return or exhaust duct shall utilize a fitting having rectangular opening with 45° transition on main duct to round or rectangular collar on branch duct side of fitting. Fitting shall be equivalent to Wichita Sheet Metal Supply Co. model HETO.
- B. A round take-off from a round supply, return or exhaust duct shall utilize a fitting having round opening with 45° transition on main duct to round collar on branch duct side of fitting.
- C. Fitting shall include a butterfly damper with quadrant operator in branch duct collar, with stand-off platform to extend quadrant beyond duct wrap for insulated duct. Provide a wing nut at each end of damper shaft.

2.9 SHEET METAL HARDWARE:

- A. Quality and configuration to conform to Ventfabrics, Inc. Piece number and description, as listed-
 - 1. Ventfabrics No. 641 damper regulator, self-blocking, die- cast, secure to sheet metal on exposed and concealed ductwork above accessible ceilings.
 - 2. Ventfabrics No. 677 damper regulator, self-blocking die- cast, chrome plated cover. To control ductwork located above an accessible ceiling or confined in wall spaces. Control from conditioned space.
 - 3. Ventfabrics No. 607 damper end bearing, die-cast for rectangular ducts, with bearing and opening for shaft inclusion.
 - 4. Ventfabrics No. 609 end bearing, die-cast for cylindrical ducts, with suitable gaskets, bearing and recess for shaft insertion.
 - 5. Ventfabrics No. 615 and 616 tandem placed U-bolts, with washer and nuts to fix damper rod to damper blade.

6. Ventfabrics No. 699 die-cast instrument test hole, with screw, cap and gasket.
7. Ventfabrics No. 611, 160 F. fusible link, 15 lb. load capacity.
8. Ventfabrics No. 613, 212 F. fusible link, 15 lb. load capacity.
9. Ventfabrics No. 90, sash lock, cadmium plated stamp steel construction, for use on reach-thru doors.
10. Ventfabrics No. 220, die-cast door pulls for use on reach- thru access doors.
11. Ventfabrics No. 150, 2 x 1-11/16-inch galvanized duct hinges, minimum 2 hinges per door, for use on reach-thru access doors.

B. Acceptable Manufacturers - Duro-Dyne, Ventfabrics, Inc., Young Regulator.

2.10 FABRICATION:

A. Ductwork -

1. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, latest edition.
2. Each duct system shall be constructed for the specific duct pressure of the system.
3. Pressure-Velocity Classification and seal class shall be as follows:
 - a. Supply, return and general exhaust ductwork shall be galvanized sheet metal constructed per requirements for the 2" water gage pressure class and seal class "C". Exposed make-up air duct to range hoods shall be stainless steel.
 - b. Kitchen hood exhaust duct shall be steel sheet with radius offsets, constructed per requirements for the 3" water gage pressure class. Concealed duct shall be fabricated from black steel, exposed duct shall be fabricated from stainless steel. All seams and joints shall be welded.
 - c. Dishwasher exhaust duct shall be stainless steel or aluminum with radius offsets, constructed per requirements for the 2" water gage pressure class. Concealed duct shall be fabricated from aluminum, exposed duct shall be fabricated from stainless steel. All seams and joints shall be sealed watertight with silicone.
4. Seal supply, return, and general exhaust ductwork with Hardcast #601 water based, UL listed sealant or approved equivalent, in accordance with SMACNA HVAC Duct Construction Standards for required static pressure construction class and seal class.

B. Rectangular duct fittings-

1. Elbows, tees and splits shall be constructed with square turns or radius turns which shall have a centerline radius 1-1/2 times the width of the duct as an absolute minimum.
2. If square turns are used, fabricate and install hollow formed turning vanes in each turn for elbows turns for elbows having equal inlet and outlet dimensions.
3. Where elbows have unequal inlet and outlet dimensions, turning vanes shall have leading and trailing edges parallel with the air flow and shall be high efficiency profile type similar to those manufactured by the Aerodyne Company. Vane assemblies shall be made with Aerodyne side rails, and vanes shall be installed on design centers as for the vanes across the full diagonal dimension of the elbow. Cut center section of each rail as recommended by manufacturer so that the required position adjustment may be made.

C. Round duct - Spiral seam, butt welded longitudinal seam, or snap lock seam.

1. Up to 12-inch: 26 gage steel spiral seam, or 26 gage steel butt welded longitudinal seam or snap lock seam, with 26 gage steel duct fittings.

2. 13 thru 18-inch: 26 gage steel spiral seam, or 24 gage steel butt welded longitudinal seam or snap lock seam, with 24 gage steel duct fittings.
 3. 19 thru 28-inch: 24 gage steel spiral seam, or 22 gage steel butt welded longitudinal seam or snap lock seam, with 22 gage steel duct fittings.
 4. 29 thru 36-inch: 22 gage steel spiral seam, or 20 gage steel butt welded longitudinal seam or snap lock seam, with 20 gage steel duct fittings.
 5. 37 thru 52-inch: 20 gage steel spiral seam, or 18 gage steel butt welded longitudinal seam or snap lock seam, with 18 gage steel duct fittings.
 6. Joints-
 - a. Beaded sleeve joints on spiral duct, 1-inch minimum lap.
 - b. Beaded crimp joints, 1-inch minimum lap, 3 screws per joint.
 - c. Draw band joint, 4-inch minimum width, lap 2-inch over each section of duct, 2 draw bolts per joint, minimum.
 - d. Companion flange joint.
- D. Round ductwork fittings-
1. Each 90 degree elbow shall be 2-piece welded, die formed construction, and shall have a center-line radius of not less than 1.5 times the duct diameter.
 2. Each elbow between 45 and 90 degrees shall be 3-piece construction, with same center-line radius requirements.
 3. Provide combination lateral elbow and tee, 90 degree tees, conical tees, double wye's and reducers each as required.

2.11 GRILLES, REGISTERS AND DIFFUSERS:

- A. Provide as scheduled.
- B. Increase size when required for installation in lined ductwork.
- C. Air Distribution-
 1. Supply units shall be designed to provide the throw and spread required with no apparent drafts or excessive air movements within the ventilated or air conditioned spaces.
 2. Provide air distribution accessories required to effect these conditions as part of the supply unit.
- D. Noise-
 1. The noise spectrum of the supply units shall be no higher than N.C.-35 as defined in the latest issue of ASHRAE Guide.
 2. Units causing excessive air movement, drafts or objectionable noise shall be replaced at no cost to the Owner.
- E. Volume Control - Furnish supply outlets with key operated volume dampers, unless otherwise specified.
- F. Gaskets - Flanges of diffusers, registers and grilles shall be gasketed with foam rubber gaskets to prevent leaking and smudging.
- G. Finish - Furnish grilles, registers, and outlets in factory baked white enamel finish, also suitable as prime coat for finish painting in the field, except as otherwise specified or scheduled.

- H. Acceptable Manufacturers - Air Concepts, Anemostat, Barber- Colman, Buensod-Stacy, Carnes, Carrier, Conners, Krueger, Metalaire, Titus, Tempmaster, Trane, Tuttle & Bailey.

PART 3 - EXECUTION

3.1 MATERIAL APPLICATION:

- A. Galvanized steel sheets - use for fabrication of the following-
1. Supply, return, exhaust ducts except as otherwise specified.
 2. Housings for coils, dampers, filters and fans.
 3. Volume control dampers.
 4. Intake and exhaust plenums, roof caps and goosenecks.
 5. Hangers for ducts.
 6. Flashing and counterflashing.
- B. Black steel sheets - use for fabrication of the following-
1. Concealed kitchen hood exhaust duct.
- C. Aluminum base alloy sheets - use for fabrication of the following-
1. Concealed dishwasher exhaust ducts.
- D. Stainless steel sheets - use for fabrication of the following -
1. Exposed dishwasher exhaust and range hood supply or exhaust ducts.
- E. Pre-insulated, closed cell, outdoor ductwork – use for fabrication of the following –
1. Supply and return ductwork installed outdoors.

3.2 DUCT SIZE AND ROUTING:

- A. Ductwork sizes and routing shown on drawings are schematic. Offset, flatten and maintain duct area, and reroute ducts where required to maintain headroom, clear light fixtures, pipes, conduits, structure and other construction.

3.3 INSTALLATION:

- A. Flexible connectors-
1. Install on inlet and outlet of each piece of air handling equipment.
- B. Flexible duct-
1. Secure to duct, apply heat resistant fire retardant compound to male end of each piece of duct, insert into flexible duct, secure with draw in accordance with manufacturer's instructions.
 2. Flexible ducts shall have developed length of not more than 4-feet and be supported to eliminate sagging and afford smooth 1-1/2 center-line (minimum) bends.
 3. Flexible duct shall not be installed above inaccessible ceilings or in other concealed locations.

- C. Volume dampers-
1. Install at each split in each run of duct.
- D. Sheet metal hardware-
1. Install as required and in accordance with manufacturer's recommendations.
- E. Air devices-
1. Each air outlet of each duct system shall be equipped with a balancing damper, either integral with the device or located in the individual branch duct to balance the airflow from that device.
 2. These devices shall be installed after the duct systems are thoroughly cleaned, with suitable accessories as specified or required for proper air distribution.
- F. Automatic dampers -
1. Install automatic dampers except dampers specified as integral parts of factory fabricated air handling unit components.
- G. Dishwasher exhaust -
1. Seal all seams and joints watertight with silicone and pitch at a minimum of 1/4-inch per foot to drain toward the hood connection or the "soiled" dishwasher connection, as applicable.
 2. All changes in direction shall be made with radius elbows.
- H. Range hood exhaust -
1. Weld all seams and joints watertight, pitch at a minimum of 1/4-inch per foot to drain toward the hood connections, and provide access doors in vertical faces, turning vanes are prohibited. Ducts shall either be enclosed in fire rated shaft construction by the General Contractor or wrapped with scheduled insulation, see plans and coordinate with General Contractor.
 2. All changes in direction shall be made with radius elbows.
- I. Pre-insulated, closed cell, outdoor ductwork –
1. Ducts shall be detailed and fully factory manufactured by a manufacturer- authorized facility.
 2. Fabrication:
 - a. Fabricated joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs according to manufacturer's written and detailed instructions.
 - b. Fabricated 90-degree mitered elbows to include turning vanes.
 - c. Fabricated duct segments in accordance with manufacturer's written details.
 - d. Duct Fittings shall include 6 inches of connecting material, as measured, from last bend line to the end of the duct. Connections on machine manufactured duct may be 4 inches.
 - e. Fabricated duct segments utilizing v-groove method of fabrication. Factory welded or cohesively bonded seams will apply to fully manufactured ductwork and fittings. Internal seams will be supplied with an unbroken layer of low VOC silicone or bonding (for paint shop applications). Each duct segment will be factory supplied with either aluminum grip pro-file or pre-insulated duct connectors in accordance with manufacturer's detailed submittal guide. Applied duct reinforcement to protect against side deformation from both positive and

- negative pressure per manufacturer's design guide based on specified ductwork size and system pressure.
- f. Designed and fabricated duct segments and fittings will be in accordance with "SMACNA Duct Construction Standards" latest edition.
 - g. Both positive and negative ductwork and fittings shall be constructed to incorporate a UL Listed as a Class 1 air duct to Standard for Safety UL 181 liner with an exterior clad for permanent protection against water intrusion.
 - h. Duct shall be constructed to exceed requirements for snow and wind loads.
3. Duct segments shall be installed by competent HVAC installers.
 4. Install ducts and fittings to comply with manufacturer's installation instructions as follows:
 - a. Install ducts with fewest possible joints.
 - b. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
 - c. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
 - d. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
 - e. Use prescribed duct support spacing as described in this specification and manufacturer's recommendations.
 5. Air Leakage: Duct air leakage rates to be in compliance with "SMACNA HVAC Duct Construction Standards" latest version per applicable leakage class based on pressure.
 6. Contractor to ensure that the ductwork system is properly and adequately supported.
 - a. Ensure that the chosen method is compatible with the specific ductwork system requirements per manufacturer's installation detail drawings. Pre-installation should be provided prior to work commencement by installing contractor for approval. .
 - b. 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.
 - c. Supports on straight runs of ductwork shall be positioned at centers not exceeding 13 feet for duct sections when fabricated in 13 foot lengths with duct girth less than 84". Larger duct sizes and short segments with duct girth greater than 84" are to be supported at 8 foot centers or less, in accordance with the manufacturer's installation details provided prior to work commencement.
 - d. Ductwork shall be supported at changes of direction, at branch duct connections, tee fittings, parallel under turning vanes and all duct accessories such as dampers, etc.
 - e. The load of such accessories to the ductwork shall be neutralized by the accessory support.
 7. Inspection: Arrange for manufacturer's representative to inspect completed installation and provide written report that installation complies with manufacturer's written instructions.
 - a. Remove and replace duct system where inspection indicates that it does not comply with specified requirements.
 - b. Perform additional testing and inspecting, at the Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.4 ERECTION:**A. Hangers-**

1. Provide round hangers, strap hangers, or trapeze shelf hangers in accordance with SMACNA standards.
2. Rectangular ducts 0 thru 47-inches wide, use 18 gage galvanized strap, 10 feet on center, 1-inch strap.
3. Rectangular ducts 48-inches and wider, use trapeze hangers formed of angle iron under duct rigidly and securely supported to building structure by threaded rods, installed per SMACNA standards.
4. Cylindrical ducts - 0 thru 36-inches in diameter, use 18 gage galvanized strap, 10 feet on center, 1-inch strap.
5. Cylindrical ducts over 37-inches in diameter, use 16 gage galvanized strap, 10 feet on center, 2-inch strap.
6. For vertical ducts - 0 thru 24-inches in any dimension, use 1 x 1 x 1/8-inch galvanized angle. Secure angle to duct at each floor level, rest angle on building structure.
 - a. Ducts 25-inches thru 60-inches use 1 1/2 x 1 1/2 x 3/16-inch galvanized angle.
 - b. Ducts over 61-inches use 2 x 2 x 3/16-inch galvanized angle.
 - c. Support to the building construction and secure to duct.
7. For cylindrical, double wall ducts, refer to drawings and SMACNA standards.
8. Support flexible ducts with 18 gage, 1-inch wide galvanized straps, with span lengths as short as necessary to prevent sagging.

3.5 ACCESS DOORS:

- A. Provide duct access doors as required to clean kitchen hood exhaust ductwork. In other ducts, provide duct access doors as required to service each item of equipment mounted in the ductwork, including but not limited to-
 1. Fire and combination fire/smoke dampers.
 2. Automatic control dampers.
 3. Coils.
 4. Volume dampers.
 5. Filters.
 6. Controls devices.
- B. Duct access doors shall be complete with latches, gaskets and frames, and shall be constructed in accordance with SMACNA manuals. Provide hinged doors wherever practicable, removable type otherwise. Access doors in insulated ducts shall be insulated.
- C. Furnish access doors as specified in Section 23 01 00 for installation in the general construction wherever duct access doors would not otherwise be accessible.
- D. Access doors shall be generously sized for the purpose intended. Demonstrate suitability of each to the satisfaction of the Architect.

3.6 TESTING:

- A. Mechanical contractor shall test grease hood exhaust duct in accordance with the requirements of the 2006 International Mechanical Code. The duct shall be tested for leakage and liquid tightness, prior to concealment or insulating of any portion of the duct system.
- B. See Section 23 99 00 for additional testing requirements.

3.7 COMPLETION:

- A. Complete each entire duct system, perform testing and cleaning operations, and leave each system in a condition with the coils cleaned, the filters clean, and debris and foreign material removed from the duct system.
- B. Install a suitable air diffuser, grille, or similar device to cover each duct outlet.
- C. Paint bare metal interior surfaces of ducts which can be seen through air inlets or outlets with a flat black paint.
- D. Operate system and prove them to be free from excessive noise, free from perceptible air leaks, free from vibration, and capable of delivering the air quantities scheduled.

END OF SECTION 23 85 00

SECTION 23 99 00 - TESTING, ADJUSTING AND BALANCING (HVAC)**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. This Section applies to the testing, adjusting, and balancing of all HVAC air and water systems in Divisions on 23 of the Specifications. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- B. The mechanical contractor shall perform system cleaning, testing and start-up before commencement of the test and balance work.

1.2 QUALIFICATIONS:

- A. Testing, adjusting and balancing (T-A-B) of systems shall be performed by a competent and experienced personnel, certified by the Associated Air Balance Council or National Environmental Balancing Bureau in those testing and balancing disciplines required for this project, having done similar work in the past, and whose qualifications shall be subject to approval.

1.3 SUBMITTALS:

- A. Submit names and qualifications of all persons proposed for testing, adjusting and balancing of mechanical systems and equipment. T-A-B work shall not begin until approval of such submittal is obtained.
- B. Submit report format as described below. T-A-B work shall not begin until approval of such submittal is obtained.
- C. See Section 23 01 00.

1.4 REPORTS:

- A. Provide reports and certificates required in each category of testing, adjusting and balancing, signed both by the technician performing the work and the Contractor as representing accurate, factual data, based on readings on the job. Include a listing of the instrumentation used for the procedures along with proof of instrument calibration. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- B. Reports shall be submitted on 8-1/2 x 11-inch paper format. Submit format for recording data for approval prior to use. Include a copy of final reports in each Operating and Maintenance Manual.

PART 2 - PRODUCTS**2.1 EQUIPMENT AND MATERIALS:**

- A. Provide all meters, instruments, equipment and materials necessary for performance of tests.
- B. Testing apparatus, not part of the permanent installation, shall remain the property of the Contractor.
- C. Provide gaskets, lubricants, and other expendable materials required to be replaced during the execution of this work.
- D. Fixed-pitch pulleys required for fan adjustments shall be provided on an exchange basis by the party responsible for the equipment installation (applies to new equipment only).

PART 3 - EXECUTION**3.1 MECHANICAL CONTRACTOR RESPONSIBILITIES PRIOR TO COMMENCEMENT OF TEST AND BALANCE WORK:**

- A. Clean all dirt and debris from equipment.
- B. Service all bearings, gear boxes, wearing surfaces and other equipment components requiring lubrication as recommended by the equipment manufacturer.
- C. Check all motor driven equipment for proper rotation.
- D. Tag all valves and label all equipment.
- E. Clean all plenums and ductwork.
- F. Perform start-up on all equipment to insure proper operation.
- G. Replace air filters.
- H. Check all refrigerant systems to insure that they are properly charged with refrigerant and oil, and that they are moisture free.
- I. Check all control devices to insure that they are installed correctly and are operating properly.
- J. Make preliminary settings and adjustments as required to insure all systems will operate satisfactorily while test and balance work is performed.
- K. Provide a set of final shop drawings to the test and balance agency.

- L. Furnish and install additional balancing valves, dampers, test plugs and gauge cocks if the test and balance agency determines that such additional items are required to properly balance the systems.

3.2 TEST AND BALANCE PERSONNEL RESPONSIBILITIES PRIOR TO COMMENCEMENT OF TEST AND BALANCE WORK:

- A. Obtain design drawings, specifications, and submittals of mechanical equipment and temperature control diagrams, and become thoroughly acquainted with the design intent.
- B. Walk the systems to become familiar with equipment locations and to determine variations of the installation from design.
- C. Prepare schematic diagrams of ductwork and piping systems as installed to facilitate reporting.
- D. Prior to beginning of testing, adjusting and balancing procedures, schedule and conduct a conference with the Engineer and representatives of the installers of the mechanical and temperature control systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.
- E. Schedule testing, adjusting and balancing procedures so that air conditioning systems are balanced during summer season and heating systems are balanced during winter season, including at least a period of operation at outside conditions within 5° F wet bulb of maximum summer design condition, and within 10° F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

3.3 MECHANICAL CONTRACTOR RESPONSIBILITIES DURING TEST AND BALANCE WORK:

- A. The mechanical contractor shall cooperate and assist the test and balance personnel in performing the test and balance work. He shall also provide craftsmen and/or technicians of the various trades as required to assist the test and balance agency in performing the test and balance work. The craftsmen and/or technicians provided shall be familiar with the installed systems.

3.4 TEST AND BALANCE PERSONNEL RESPONSIBILITIES DURING TEST AND BALANCE WORK:

- A. Provide temperature controls contractor with temperature, pressure and flow measurements as required for the calibration and verification of temperature controls system operation.
- B. Perform testing, adjusting and balancing procedures for the various systems as described herein and in accordance with applicable standards of the National Environmental Balancing Bureau, Associated Air Balance Council, and the American Society of Heating and Refrigeration Engineers 1991 Handbook, Chapter 34.

3.5 SYSTEM VERIFICATION AND CALIBRATION:

- A. Provide attendance by a qualified technician to work in cooperation with other participants to calibrate, integrate, and verify operation of all components and equipment described in this work.
1. Make all repairs, adjustments and programming changes necessary to accomplish the desired operation of the HVAC systems.
 2. See MECHANICAL SYSTEM VERIFICATION AND CALIBRATION of Specification Section 23 01 00 for complete requirements.

3.6 HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS:

Note - items marked TBA shall be the responsibility of the Test and Balance Agency; items marked MC shall be the responsibility of the Mechanical Contractor.

1. TBA - Balance all new or existing supply and exhaust air systems in accordance with SMACNA and AABC standards, by the use of a direct reading instrument such as "Anemotherm" or "Velometer" which has been properly calibrated.
2. TBA -The quantity of airflow at each inlet or outlet shall be within 10 percent of the design cfm shown on the Drawings.
3. TBA - Blank-off sufficient filter area to simulate a dirty filter condition (maximum pressure drop across filter bank).
4. For variable volume systems, furnish typewritten data for both maximum cooling and maximum heating air delivery, tabulating –
 - a. Quantity of air in cfm at each air supply outlet.
 - b. Dry bulb temperature of the supply air.
 - c. Outdoor dry and wet bulb temperature at the time the above tests are conducted.
5. TBA - Furnish typewritten data tabulating-
 - a. Quantity of air in cfm at each air outlet and inlet.
 - a. Dry bulb temperature in each room.
 - b. Dry bulb temperature of the supply air.
 - c. Outdoor dry and wet bulb temperature at the time the above tests are conducted.
6. MC - Adjust belts, sheaves and the alignment of air handling equipment.
7. MC - Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
8. MC - Oil or grease bearings in accordance with manufacturer's instructions.
9. TBA -Furnish typewritten data taken at each air handling unit, for both clean and dirty filter conditions, tabulating-
 - a. Total quantity of supply air in cfm.
 - b. Total quantity of return air in cfm.
 - c. Total quantity of outside air in cfm.
 - d. Rpm of each fan or blower.
 - e. Rpm of each motor.
 - f. Voltage and ampere input of each motor (one reading for each phase leg on 3 phase motors).
 - g. Pressure in inches water gage at inlet and discharge of each fan or blower.
 - h. Furnish manufacturer's fan curve with calculated operation condition shown thereon.

10. TBA - Furnish air handling unit test data for variable volume systems at both maximum system air delivery and maximum turn-down.
- B. Outside/Return Air Mixing Chambers-
1. TBA, Test each outside/return air mixing chamber for air handling units to prove actual air mixture conditions as specified. Balance return and outside air quantities for mixing plenums to the flows specified.
 - a. TBA, Outdoor temperature at the time the above tests are conducted.
- C. Rooftop Heating/Cooling Outside Air Supply Units -
1. MC, Adjust, align and service rooftop units in accordance with manufacturer's recommendations and as required to achieve proper operation. Oil or grease bearings in accordance with manufacturer's instructions. Adjust belts and sheaves. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
 2. Furnish typewritten data for each system, for both clean and dirty filter conditions, tabulating-
 - a. MC, Suction and condensing temperatures, and pressures.
 - b. TBA, Temperatures of entering and leaving condenser air.
 - c. TBA, Ampere input of compressor motors under full load (for each phase leg).
 - d. TBA, Rpm of each condenser fan and motor.
 - e. TBA, Rpm of each condenser fan and motor.
 - f. TBA, Quantity of supply air in cfm.
 - g. TBA, Quantity of exhaust air in cfm.
 - h. Entering and leaving supply air dry bulb and wet bulb temperature for supply air and exhaust air stream through energy recovery media.
 - i. TBA, Evaporator face velocity in fpm.
 - j. TBA, Evaporator entering and leaving dry and wet bulb temperature.
 - k. TBA, Total quantity of supply air in cfm.
 - l. TBA, Total quantity of return air in cfm.
 - m. TBA, Total quantity of outside air in cfm.
 - n. TBA, Rpm of each supply fan or blower.
 - o. TBA, Rpm of each supply fan motor.
 - p. TBA, Voltage and ampere input of each fan motor (one reading for each phase leg on 3 phase motors).
 - q. TBA, Pressure in inches water gage at inlet and discharge of each supply and exhaust fan or blower.
 - r. TBA, Heat exchanger entering and leaving dry bulb temperature.
 - s. TBA, Outdoor temperature at the time the above tests are conducted.
- D. Exhaust Fans -
1. MC, Adjust, align and service exhaust fans in accordance with manufacturer's recommendations and as required to achieve proper operation. Oil or grease bearings in accordance with manufacturer's instructions. Adjust belts and sheaves. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
 2. TBA, Furnish typewritten data for each exhaust fan, tabulating-

- a. Total quantity of exhaust air in cfm.
 - b. Rpm of fan.
 - c. Rpm of motor.
 - d. Voltage and ampere input of fan motor (one reading for each phase leg on 3 phase motors).
 - e. Pressure in inches water gage at inlet and discharge of fan.
- E. Kitchen Hood Systems –
1. TBA, Perform testing of kitchen equipment ventilation systems in accordance with the requirements of the 2012 International Mechanical Code, to verify exhaust airflow, capture and containment.
- F. Air Curtains:
1. MC, Perform the following field tests and inspections and prepare test reports:
 - a. After installing air curtains completely, perform visual and mechanical check of individual components.
 - b. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation.
 - c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 2. MC, Adjust air-directional vanes.
 3. TBA, Furnish typewritten data for each system, tabulating -
 - a. Voltage and ampere input of heating coil and fan motor (one reading for each phase leg on 3 phase loads).
 - b. Entering and leaving air temperature with heating coil energized.
 - c. Outdoor temperature at the time above test is conducted.
- G. Electric Heaters:
1. MC, Perform the following field tests and inspections and prepare test reports:
 - a. After installing air curtains completely, perform visual and mechanical check of individual components.
 - b. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation.
 - c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 2. MC, Adjust air-directional vanes, where applicable.
 3. TBA, Furnish typewritten data for each system, tabulating -
 - a. Voltage and ampere input of heating coil and fan motor, as applicable (one reading for each phase leg on 3 phase loads).
 - b. Entering and leaving air temperature with heating coil energized.
 - c. Outdoor temperature at the time above test is conducted.

END OF SECTION 23 99 00

SECTION 25 90 00 - TEMPERATURE CONTROLS**PART 1 - GENERAL****1.1 SCOPE:**

- A. Provide a complete and operating fully functional Building Control System (BCS) of electronic digitally processed temperature control system with energy management and monitoring functions for the building HVAC equipment and other systems included as part of the work for this Division.
- B. The controls specified in this section will be an expansion of the existing Johnson Controls Inc. system already serving the existing building.
- C. The BCS shall be comprised of a series of BACnet compliant digital controllers and sensors and network extension to connect to the existing control and energy management system. Provide additional programming, adjustment, and/or configuration of the system administrative software to provide user monitoring and operation of the HVAC equipment consistent with the existing user interface..
- D. Electric controls and mechanical devices for all HVAC items indicated on drawings, required for implementation of the operating sequences and as described hereafter including electronics, dampers, valves, wiring, interface devices and panels.
- E. A communications network to allow data exchange from each electronic controller to each other, controllers to user interface units and to a main user interface personal computer. Provide all interface components, routers, bridges, switches, hubs, modems and like communications equipment necessary for full access of the BCS network to the building operator.
- F. Installation, check out and calibration of all control devices and systems including HVAC equipment manufacturer supplied control devices supplied by this Division and all other HVAC controls supplied under this contract.
- G. Provide all software tools for installation, operation, modification and adjustment of control programs and electronic controller resident firmware settings. Provide licenses for all software residing in the BCS and user interface and transfer these licenses to the Owner prior to completion.
- H. The requirements of Section 23 01 00, Basic Mechanical Requirements, apply to this work.

1.2 RESPONSIBILITY:

- A. This Contractor shall be responsible for the complete installation of the control systems for all electrical equipment, including all power supply and control signal wiring and ancillary equipment necessary to provide a complete and fully operative control system as herein

specified. Where required by applicable codes, this contractor shall provide the services of a licensed electrician to complete this work.

- B. Any electrical installation not specifically indicated on the electrical plans shall be the responsibility of this contractor.
- C. All indications or notations of specific field points and equipment components are intended to represent a subset of the complete hardware and requirements for this work. Provide all hardware, software, wiring and pneumatic installation required for a complete system with fully functional operation as described herein.
- D. Provide all required control equipment, circuitry, interface and connections for smoke control implemented by HVAC equipment and components. Refer to drawings and control sequences for other related information.

1.3 ACCEPTABLE MANUFACTURERS:

- A. Johnson Controls, Inc.

1.4 QUALITY ASSURANCE:

- A. Installer:
 - 1. This system shall be engineered, installed, started and calibrated by a factory authorized and currently certified supplier.
 - 2. Installer shall have a minimum of five years experience in the installation of temperature control systems of similar size and scope.
- B. Design Criteria: Proposed substitutions shall be submitted in accordance with procedures outlined elsewhere in this Specification.
- C. The system shall be installed by competent mechanics, regularly employed by the controls manufacturer with full responsibility for proper operation of the system including debugging and calibration of each component in the system.

1.5 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with other sections of this Specification. Indicate construction materials, sizes, capacities, quantities, and related hardware requirements.
- B. Instructions: Furnish Owner with Instruction Manual describing operation of temperature control system in accordance with other sections.
- C. Submit the following for each control system:
 - 1. System architecture showing all digital devices and interconnection.
 - a. A complete field points list shall be included.

2. Data sheets of all products
 3. Valve, damper and well and tap schedules showing size, configuration, capacity, pressure drop and location of all equipment.
 4. Data forms for identification of initial and user adjustable parameters.
 5. Equipment lists of all proposed devices and equipment.
 6. Software design data including:
 - a. Sequence of operation relating to all flowchart functions.
 - b. List of all programmed alarm points with proposed initial alarm threshold setpoints.
 7. Written commissioning and checkout procedure for each control system.
 8. Submit maintenance brochures after completion of the work. The maintenance brochure shall include operating instructions, specifications, and instruction sheets for each instrument, and a complete set of record drawings.
- D. Submittal shall also include a control network schematic diagram depicting connected devices and a description of the communication type and media.
1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.
- E. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. Mechanical and Electrical contractors shall provide as-builts for their portions of work. This contractor shall be responsible for as-builts pertaining to overall BCS and FMS architecture and network diagrams. All as-built drawings shall also be installed into the FMS server in a dedicated directory.
- F. See Section 23 01 00 for additional submittal requirements.

1.6 COORDINATION:

- A. Manufacturer shall be responsible for details and dimensions not controlled by job conditions and shall show on his shop drawings required field measurements beyond his control. Coordinate with responsible trades to establish, verify, and maintain field dimensions and job conditions.
- B. Consult with other trades in advance and make provisions for their work to avoid cutting and patching.
- C. Where control system components interface to mechanical equipment or internal controls this Contractor shall be responsible for signal conversion, adjustment or configuration so as to conform to the equipment manufacturers' strictest requirements. Provide all hardware, software, wiring and installation required.

PART 2 - PRODUCTS**2.1 LOCAL CONTROL PANELS:**

- A. Provide standard cabinets. Controllers, relays, switches, terminal strips, interface devices, time clocks and similar devices except limit and safety controllers shall be located inside fully enclosed painted steel cabinets equipped with grounding backboards. Equipment room panels shall have hinged doors and shall also contain all power supplies, load relays, transducers, and associated equipment.
- B. All panel electronics, discrete control components and interface devices shall be installed in suitable enclosures. Groups of devices serving a single air unit or equipment system within a single room shall be installed in the same enclosure.

2.2 ELECTRIC SYSTEM DEVICES:

- A. All electric switch devices shall be selected for the applied load and UL listed for the application. All water thermostats shall be provided with a separate copper, monel or stainless steel well.
- B. All automatically controlled devices, unless specified otherwise, elsewhere, shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two position action and tight close-off. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
 - 1. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by signal sequencing with separate analog outputs.
- C. Provide transducers, 2-position relays, sequencing relays, and other controls necessary to comply with the scheduled control sequences and provide for properly operating the automatic control system.
 - 1. Relays shall have C isolated contacts rated for 1.5 load amperes and horsepower if switching power supply to a motor.
- D. Provide low voltage power supplies and/or transformers where required for supplied component operation. Power supply devices shall be installed in enclosures with fusing and disconnecting means. All power supply equipment associated with an electronic controller shall be monitored by the digital control system. An input shall be utilized to sense operation of the power supply. If the supply fails a system alarm shall be generated.

2.3 DATA INPUTS AND OUTPUTS:

- A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be

high sensitivity and matched to the loop gain requirements for precise and responsive control. In no case shall computer inputs be derived from pneumatic sensors or thermocouples.

- B. Temperature sensors shall be precision thermistors or resistance temperature detector type with high thermal resistive coefficients for the range to be measured.
 - 1. Space temperature sensors shall be provided with blank commercial type locking covers. Covers for air zones shall have external setpoint adjustable knob scaled and calibrated in degrees F and override buttons.
 - 2. Space humidity sensors shall be integrated into the space temperature sensor enclosures.
 - 3. Duct temperature sensors shall be rigid stem (12 inches minimum) or averaging type (20 feet minimum) as specified in the sequence of operation. Water sensors shall be provided with separable copper, monel or stain less-steel well.
- C. Relative humidity sensors shall be capacitance type with 10% to 90% range. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with covers identical to temperature sensors.
 - 1. Room humidity and temperature sensors shall be mounted in wall or ceiling mounting brackets with removable brushed stainless covers specifically design for finished space applications. Sensor enclosures shall be of minimum size required.
 - 2. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- D. Current sensing switches shall be adjustable from 0.2 to 20 amperes or a higher range where applicable with 5% repeatability. Set current switches to release at a level between a normally loaded condition and unloaded condition so that a lost coupling or belt occurrence is detectable. For two-speed motorized equipment calibrate and test to detect operation of equipment at lowest speed.
- E. Control relays and analog output transducers shall be compatible with electronic controller output signals. Relays shall be suitable for the loads encountered.

2.4 BCS CENTRAL HARDWARE:

- A. For the system interface provide all required hardware, software, programming and interface equipment needed to permit full system communication and operation with the existing building control system.
- B. Provide system PC with all hardware, software and programming necessary for system operator interface and system control at the site.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install complete a control system including: Wiring, thermostats, controllers, sensors, transducers, control operators, transformers, relays, switches and other necessary devices.
- B. Provide complete systems to accomplish the indicated sequence of operation.
- C. Provide wiring and components for limiting, timing and interlocking required for safe operation of controlled equipment in accordance with manufacturers' recommendations.
- D. Install all control components in strict accordance with manufacturer's recommendations.
- E. All room thermostats, temperature and humidity sensors shall be installed 4'- 0" A.F.F. unless otherwise noted.
- F. The Building Control System (BCS) shall be designed, installed, and commissioned in a turnkey, fully implemented and operational manner including all labor and materials required for the completion of these systems and not noted in other sections of these specifications.
- G. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring in finished areas with exposed structure shall be installed in conduit. ALL WIRING AND RACEWAYS SHALL BE ATTACHED TO THE BUILDING STRUCTURE AND ROUTED ABOVE THE BOTTOM OF THE STRUCTURAL COMPONENTS. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All control circuitry shall have independent support from other building systems.
- H. The BCS contractor shall be responsible for all electrical installation required for a fully functional control system and not required by the electrical plans and specifications as Division 26 work. All wiring shall be in accordance to all local and national codes. All line voltage wiring, all wiring exposed in finished areas shall be installed in conduit and in accordance to the electrical specifications. All electronic wiring shall be #18 AWG minimum, plenum rated cable and shielded if recommended by the manufacturer for the application. All wiring in the mechanical rooms shall be installed in an approved manner.
- I. The BCS contractor shall enter all computer programs and data files into the related computers including all control programs, initial approved parameters and settings, and English descriptions.
 1. The BCS contractor shall maintain CD ROM copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training session, and one copy shall be archived in the BCS contractor's local software vault.
- J. Provide modifications to software throughout the warranty period to accommodate the mechanical systems behaviors observed in real life operation and the Owner's determination of optimal scheduling and system sequences.

3.2 SEQUENCE OF OPERATION: See drawings for equipment specific control sequences.

- A. Sensor monitoring:

1. Alarm the failure of any system sensor by comparison against normal high and low limits of sensed variable. Provide user adjustable threshold setpoints for all alarm levels.

B. Alarms

1. Alarms, general:
 - a. Loss of signal - all system inputs.
 - b. Failure of all sensors.
 - c. Failure of all system controller communications.
 - d. Failure to start all motorized and heating equipment.
 - e. Failure to start all fans and pumps.
 - f. Loss of status with run command.
 - g. All system temperatures - outside of operating limits.
 - h. All system pressures – outside of limits.
 - i. Rapid cycling of any equipment.
2. Other equipment alarms:
 - a. Alarm from manufacturer control panel (i.e. sewage ejector panel).
 - b. LonWorks or Bacnet interface transmitted failure or alarm.
 - c. Smoke detector activation where applied for fan control.
3. Intelligent alarm function:
 - a. Where cycling of threshold variable is expected during normal sequencing (i.e. low pressure during fan wind-up) alarm function shall incorporate adequate time delay or other applicable discrimination logic to avoid nuisance alarms.

C. Monitoring system operation:

1. Provide trend logs of the system data and store data on the Facility Management System server.
2. Record every 15 minutes:
 - a. All temperature sensor points including duct, piping and room sensors.
 - b. All room temperature sensor setpoints.
 - c. All humidity sensor data
3. Record change of state:
 - a. All smoke detector alarms.
 - b. All fan status.
 - c. All compressor run status.

3.3 FAIL-SAFE OPERATION:

- A. Control operators shall be selected, applied and installed in such a manner that upon a local power failure, the "normal" position of each operator shall be such that no physical damage will

be caused to any equipment as a result of loss of control power or electrical power to control devices or the entire unit.

- B. Power Fail / Auto Restart: Provide for the automatic orderly and predefined shutdown of parts or all of the BCS following total loss of power and loss of power to portions or of the BCS. Provide for the orderly and predefined scheduling of controlled equipment to return to normal, automatically time scheduled, operation as a result of the auto restart processes.
- C. Maintain the BCS real-time clock operation during periods of power outage for a minimum of 72 hours.

3.4 Alarms:

- A. Sensor monitoring: Alarm the failure of any system sensor by comparison against normal high and low limits of sensed variable.
 - 1. Each room temperature sensor shall have an associated alarm with separate alarm levels for occupied periods and unoccupied periods.
 - 2. Each room humidity sensor shall have an associated alarm with separate alarm levels for occupied periods and unoccupied periods.
- B. Provide alarm reporting and functionality consistent with the existing system functions.
- C. Alarms shall be functionally intelligent so that high or low sensed levels will not be alarmed when the associated equipment or system is not active. i.e. water temperature shall not be alarmed when the associated pumps are off and shall be delayed to allow the starting system to 'catch up' and gain control of the sensed variable.

3.5 SOFTWARE CUSTOMIZATION:

- 1. Provide customization of front end software to facilitate user operation and maintenance of controlled equipment.
- 2. Provide simple one-step means of implementing manual start/stop of each HVAC equipment item. Each equipment item shall be equipped with a manual override feature with a user defined time period.
- 3. Manual control of selected equipment items or systems shall automatically initiate start up of other required systems to permit selected equipment operation. (i.e. If an fan coil is selected for off hours operation the chilled water pump will start automatically.)
- 4. Provide display real-time reports for each mechanical equipment item and HVAC system. Each report shall display all sensed data points, system output statuses, setpoints, system variables and other relevant data.
 - a. Provide display reports of sensor data provided by equipment BacNet interface of all equipment under operation of equipment manufacturer supplied controllers equipped with BacNet.
- 5. Provide displays that indicate relevant temperatures and identify setpoints for all like equipment. Provide a display for each group of equipment units.
- 6. Provide displays that indicate all room temperatures and related setpoints.
- 7. Provide displays that facilitate user adjustment of all setpoints for each equipment item, each HVAC system or each similar equipment group.

3.6 VALIDATION:

- A. The BCS contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the specifications and sequence of operations submitted.

3.7 ADJUSTING:

- A. Adjust and place entire system in operation. Provide readjustment necessary to accomplish specified results during the guarantee period.
- B. All setpoints, reset schedules, time delays, gain factors, span constants, etc. shall be adjusted by testing operation of the air and water handling systems and logging results.
- C. Coordinate calibrating efforts with the project test and balance agency for verification of temperatures, pressures and flows. Include system adjustment operation logs in the O & M Manuals.
 - a. Coordinate sequencing of compressorized equipment with equipment manufacturer recommended operation and time delays.
 - b. Provide all safeties and operating limits recommended by equipment manufacturers.
- D. Corrective software modifications shall be made during the check-out and start-up periods. Software parameters and entire algorithms shall be updated or replaced to optimize the operation of building equipment and system effectiveness. All software tuning and adjustment shall be made in close coordination with the equipment supplying contractors and the equipment manufacturers to ensure proper operation. Record all changes and update all user documentation and on user and manufacturer archived software disks.
- E. Provide adjustments and changes to control software requested by Owner after one year (all seasons) of operation. This programming service shall be provided under the system construction warranty. The contractor shall notify the Owner and request changes and implement prior to completing the warranty period.

3.8 TRAINING:

- A. All training shall be by the BCS contractor and shall utilize specified manuals and as-built documentation. See list of required documentation below.
- B. Following the completion of work, the Owner's representative shall be given a minimum of (2) two hour sessions of instructions on operation and maintenance of the completed system. Training topics shall include:
 - 1. Sequence of Operation review
 - 2. Selection of all displays and reports
 - 3. Troubleshooting software

- C. After the one year warranty period provide a scheduled training review session for one half day. Coordinate this session with the Owner's schedule so that he may arrange attendance by appropriate staff.

3.9 SYSTEM VERIFICATION AND CALIBRATION:

- A. See Section 23 01 00.

3.10 WARRANTY:

- A. All components, system software, parts and assemblies supplied by the BCS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date.
- B. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the BCS contractor at no charge to the owner during the warranty period.
- C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

3.11 DOCUMENTATION:

- A. An Operators Manual shall be provided with graphic explanation of keyboard use for all operator functions specified under Operator Training.
- B. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.
- C. Two Operators Manuals and four As-Built Manuals shall be provided to the owner.

END OF SECTION 25 90 00

SECTION 26 01 00 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL:

- A. All work covered by this section of these specification shall be accomplished in accordance with the respective drawings, information or instructions to bidders, general requirements, and the general conditions of these specifications. Any supplementary conditions, special conditions, addenda, or directives which may be issued by the Architect herewith or otherwise shall be complied with in every respect.
- B. Bidders shall determine the contents of a complete set of drawings and specifications and be aware that they may be bidding from a partial set of drawings, applicable only to the various separate contracts, sub-contracts, or trades as may be issued for bidding purposes only. The complete scope of work for the electrical trade in this project are illustrated on the complete Contract Documents which consist of the combined Architectural, Structural, Plumbing, Heating, Ventilating, and Air Conditioning plans and specifications. Each Bidder shall thoroughly acquaint himself with all the details of the complete set of drawings and specifications before submitting his bid. All drawings and specifications form a part of the contract documents for each separate contract and shall be considered as bound therewith in the event partial sets of plans and specifications are issued for bidding only. The submission of bids shall be deemed evidence of the review and examination of all drawings, specifications, and addenda issued for this project as no allowances will be made because of unfamiliarity with any portion of the complete set of documents.
- C. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.
- D. Existing systems shall be left in perfect working order upon completion of all new work.
- E. Any equipment which is removed and not reinstalled shall be delivered on site to the Owner, or removed by the Contractor, as directed by the Owner.

1.2 SUB-CONTRACTOR QUALIFICATIONS:

- A. Sub-Contractor (as a company) and his job superintendent for their portion of the work shall have at least three years of satisfactory experience in completion of projects of comparable size and complexity. Evidence of this experience will be required before approval of the Architect as being acceptable for their portion of the work.

1.3 SCHEDULE:

- A. The schedule and sequence of work must be carefully coordinated through the General Contractor, with the Owner, to ensure that all work performed within the existing building will result in a minimal amount of noise, dust and disruption to the activities in the existing building.

- B. All interruptions of existing services must be coordinated through the General Contractor, with the Owner, to minimize inconvenience and disruption to the activities in the existing building. All interrupted services shall be restored as quickly as possible. All interrupted systems shall be thoroughly cleaned and tested prior to being placed back into operation.

1.4 SCOPE:

- A. The work included under this specification consists of the furnishing of all labor, materials, tools, transportation, services, etc., which are applicable and necessary to complete the installation of the systems described in these specifications, illustrated on the accompanying drawings, or as directed by the Architect.
- B. In general, the various lines and raceways to be installed by the various trades under this specification shall be run as indicated, as specified herein, as required by particular conditions at the site, as required to conform to the generally accepted standards and as required by all governing Building Codes so as to complete the work in a neat and satisfactorily workable manner. Run work parallel or perpendicular to the lines of the building unless otherwise noted.
- C. The construction details of the building are illustrated on the Architectural and Structural Drawings. Be thoroughly acquainted with the details before submitting a bid as no allowances will be made because of unfamiliarity with these details. Place all inserts to accommodate the ultimate installation of pipe hangers in the forms before concrete is poured. Set sleeves in place in forms before concrete is poured, and in masonry walls while they are under construction.
- D. The Electrical Contractor shall coordinate with the General Contractor, the requirements of all trades for temporary power during the construction phase. The Electrical Contractor shall provide the installation of temporary power distribution for those requirements as part of his work and at no additional cost to the owner.
- E. The Contractor shall coordinate the interruption of service to the existing building with the Owner and shall bear all costs and be fully responsible for scheduling his work to accommodate all Owner activities at this facility. He shall also provide temporary electrical service to the existing electrical systems as necessary so that the Owner may have the use of undisturbed portions of the existing building.

1.5 INSPECTION OF SITE:

- A. Visit the site, verify all existing items shown on plans, or specified, and be familiar with the working conditions, hazards, existing grades, actual formations, soil conditions, and local requirements involved; submission of bids shall be deemed evidence of such visit. All proposals shall take these existing conditions into consideration and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

1.6 UTILITIES, LOCATIONS AND ELEVATIONS:

- A. Locations and elevations of the various utilities included within the scope of this work have been obtained from city and/or other substantially reliable sources and are offered separately from the Contract Documents, as a general guide only, without guarantee as to accuracy. Examine the site, verify the locations, elevations, and availability of all utilities and services

required, and be adequately informed as to their relation to the work; the submission of bids shall be deemed evidence thereof.

1.7 INSTRUCTIONS:

- A. When specified in other Sections, the contractor shall furnish the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation, and maintenance, including pertinent safety requirements of the equipment or system specified. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation.
- B. The number of man-days of instruction to be furnished shall be as specified in the various Sections of the Specification.

1.8 CODE REQUIREMENTS:

- A. All work shall comply with the provisions of these specifications, as illustrated on the accompanying drawings, or as directed by the Architect, and shall satisfy the National Electrical Code and all applicable local codes, ordinances, or regulations of the governing bodies, and all authorities having jurisdiction over the work, or services thereto. In all cases where alterations to, or deviations from, the drawings and specifications are required by the authority having jurisdiction, report the same in writing to the Architect and secure his approval before proceeding. Upon completion of the work, furnish a statement from the inspecting authority stating that the installation has been accepted and approved. Provide complete utility service connections as directed, and submit, as required, all necessary drawings; secure all permits and inspections necessary in connection with the work, and pay all legal fees on account thereof. In the absence of other applicable local codes, acceptable to the Architect, the National Electric Code shall apply to this work.

1.9 MATERIALS AND WORKMANSHIP:

- A. All materials unless otherwise specified shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality unless otherwise specified.
- B. All manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature unless specifically herein specified to the contrary.
- C. All work shall be performed by competent workmen and executed in a neat and workmanlike manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials, and the temporary plugging of open conduits during construction. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

1.10 COOPERATION:

- A. All work under these specifications shall be accomplished in conjunction with other trades on this project in a manner which will allow each trade to complete his work in a timely fashion.
- B. Maintaining contact and being familiar with the progress of the general construction and timely installation shall be the responsibility of this trade to expedite this contract and avoid unnecessary delays in the progress of other trades.
- C. Should any question arise between the trades as to the placing of lines, ducts, conduits, fixtures, or equipment, or should it appear desirable to remove any general construction which would affect the appearance or strength of the structure, reference shall be made to the Architect for instructions.

1.11 DRAWINGS AND SPECIFICATIONS:

- A. The drawings show diagrammatically the locations of the various conduits, fixtures, and equipment, and the method of connecting and controlling them. It is not intended to show every connection in detail and all fittings required for a complete system. The systems shall include, but are not limited to, the items shown on the drawings. Exact locations of these items shall be determined by reference to the general plans and measurements at the building and in cooperation with other trades and, in all cases, shall be subject to the approval of the Architect. The Architect reserves the right to make reasonable change in the location of this work without additional cost to the Owner.
- B. Should any changes be deemed necessary in items shown on the contract drawings, the shop drawings, descriptions, and the reason for the proposed changes shall be submitted to the Architect for approval.
- C. Lay out all work maintaining all lines, grades, and dimensions according to these drawings with due consideration for other trades and verify all dimensions at the site prior to any fabrication or installation; should any conflict develop or installation be impractical, the Architect shall be notified before any installation or fabrication and the existing conditions shall be investigated and proper changes effected without any additional cost.
- D. Titles of Sections and Paragraphs in these specifications are introduced merely for convenience and are not to be construed as a correct or complete segregation or tabulation of the various units of material and/or work.

1.12 ARCHITECT'S APPROVAL:

- A. In the statement under this contract where "approval" is required or requested, it is understood that such approval must be obtained from the Architect in writing before proceeding with the proposal, and an adequate number of copies of any such proposal shall be submitted to the Architect.
- B. The approval of the Architect of any material, changes, drawings, etc., submitted will be considered as general only and to aid the Contractor in expediting his work. Such approval as may be given does not in any way relieve the Contractor from the necessity of furnishing all materials and performing all work as required by the Drawings and Specifications.

1.13 LOCAL RESTRICTIONS:

- A. Contractor shall become familiar with rules and regulations of the City, County, and State; or any other authority having jurisdiction over this project; and if, in his opinion, any work or materials shown on the drawings or specified do not comply with these rules and regulations as to size, type, capacity, and quality, he should make it known to the Architect prior to the submission of his bid.

1.14 ELECTRIC WIRING:

- A. Except for such items as are normally wired up at the point of manufacture and so delivered, and unless specifically noted to the contrary herein, the Electrical Contractor shall do all electric wiring for power supply, including contactors, starters, etc. The other Contractors will erect all motors in place ready for connections. The Electrical Contractor shall mount all starters, as directed, furnishing supporting structures where necessary. The other Contractors will furnish with each item requiring electrical connections, the necessary instructions and wiring diagrams to this Sub-Contractor.

1.15 RESPONSIBILITY:

- A. This Contractor will be held responsible for the satisfactory and complete execution of all work specified or indicated. He shall produce complete finished operating systems and provide all incidental items required as part of this work, regardless of whether such item is particularly specified or indicated.

1.16 HANGERS AND INSERTS:

- A. All hangers, brackets, clamps, etc., shall be of standard weight steel. Perforated strap hangers shall not be used in any work. When two (2) or more conduits are run parallel, they may be supported on trapeze hangers. Other hangers shall be constructed with rods and hanger adjusters of adequate size to carry the loads imposed.
- B. Unless otherwise shown on the drawings, all horizontal runs of conduit and piping shall be suspended from the floor or roof construction, as the case may be, by means of approved hangers spaced not farther apart than ten feet (10') on centers, except that hangers for piping 1-1/4" in size and smaller shall not be spaced more the 8 feet on centers. Vertical risers shall be supported by approved riser clamps or supports installed at the respective floor lines.
- C. Supports and hangers shall be installed to permit free expansion and contraction in the raceway systems. Where necessary to control expansion and contraction, the raceways shall be guided and firmly anchored; anchors shall be approved by the Architect and shall be designed for equal effectiveness for both longitudinal and transverse thrust. No conduit shall be self-supporting, nor shall it be supported from equipment connections. Transmission of vibrations, noise, etc., shall be considered and any special suspension with vibration dampers to minimize transmission shall be used where necessary.
- D. Where ducts interfere with the proper location of hangers, furnish and install trapeze hangers. Trapeze hangers may be used to support groups of conduit run parallel.

- E. Above roof - Support conduit at no more than 8 feet on center, with manufactured pipe supports: Miro Industries Model 3-R to match existing supports on roof. The conduit supports shall be a roller-bearing type designed to support piping or conduit, and to absorb thermal expansion and contraction of piping or conduit thus preventing damage to roof membrane. The pipe or conduit shall rest on a polycarbonate resin roller and a glass- filled nylon rod situated in a polycarbonate resin seat.

1.17 GUARANTEE:

- A. The entire system shall be guaranteed to be complete and installed in accordance with these plans and specifications.
- B. Guarantee all new materials and workmanship for a period of one year from and after date of acceptance of installation. Replace, during the period of the guarantee, any parts found to be defective in their operation, without cost to the Owner.
- C. Incandescent lamps shall be excepted from requirements of this guarantee, but all electric discharge and quartz lamps shall be covered under the guarantee.

1.18 REFERENCE ABBREVIATIONS:

- A. References are made in the various electrical sections to technical societies, codes, specifications, trade organizations, and regulatory authorities in accordance with the following abbreviations:
1. FM - Factory Mutual
 2. FS - Federal Specification
 3. IEEE - Institute of Electrical and Electronics Engineers.
 4. IPCEA - Insulated Power Cable Engineers Association
 5. IRI - Industrial Risk Insurors
 6. ISO - Insurance Services Organization
 7. NEC - National Electrical Code(NFPA Pamphlet No. 70)
 8. NEMA - National Electrical Manufacturer's Association
 9. NFC - National Fire Codes
 10. NFPA - National Fire Protection Association
 11. UL - Underwriters Laboratories, Inc.

1.19 SHOP DRAWINGS AND DATA TO BE SUBMITTED:

- A. SUBMITTALS WHICH DO NOT MEET THE FOLLOWING REQUIREMENTS WILL BE IMMEDIATELY REJECTED WITHOUT FURTHER REVIEW!
1. Catalog cutsheets and brochures will be preceded by a neatly arranged cover sheet having ample room for shopdrawing stamps and bearing the following information in a prominent, immediately visible location and size:
 - a. Equipment name or number as referenced in the contract Documents (example: "AHU-A" or "Type A" light fixture).
 - b. All options or accessories provided.

- c. Applicable Specification section and paragraph numbers.
2. Substitutions -
 - a. Cross reference individual manufacturer and catalog numbers of substitute products to those of specified material.
 - b. Prior to requesting permission to use substitute or alternate products, the Contractor shall investigate and make certain that the product-
 - 1) Conforms with the standard of performance and quality specified.
 - 2) Will physically fit in the space allocated, with sufficient access and maintenance space.
 - 3) Involves no additional costs to the Owner or extended construction time.
 - c. Should the use of a substitute product entail any changes in details or construction, the changes and information documenting the complete coordination with all affected trades shall be submitted prior to submittal of substitute or alternate products
 - d. Provide with requests for permission to use substitute or alternate products, drawings, specifications, samples, performance data and other information as may be required to assist in determination of acceptability of the product. The burden of proof is the Contractor's responsibility.
3. All similar or related items shall be submitted together under one cover sheet (i.e. fixtures, raceways, wiring, equipment). Do not piece-meal submittals!!!

B. Submittal Items:

1. Submit manufacturer's certified data relative to equipment required for the installation of the electrical and electronic systems.
2. Submit adequate engineering data on each piece of equipment to allow a careful check of compliance with the technical requirements of the Contract Documents. Clearly indicate on submittal data the manufacturer's name, piece number, equipment capacity, and other applicable technical data.
3. Equipment, Electrical Systems Submittals:
 - a. New Power Distribution Equipment.
 - b. Wiring Devices and Cover Plates.
 - c. Lighting Fixtures.
 - d. Fire Alarm Systems.
 - e. Other Special Systems.

1.20 OPERATING AND MAINTENANCE MANUALS:

- A. Bind in looseleaf binders with the words, "Operating and Maintenance Manual" and the Project identification imprinted on the cover. Prepare three complete sets of records for the Owner, with table of contents, index, and tabbed Section dividers.
- B. During the construction period, accumulate the following for inclusion in the Operating and Maintenance Manuals-

1. Copies or warranties and guarantees on each piece of equipment installed.
 2. Fixture brochures.
 3. Wiring and Control Diagrams.
 4. Approved Shop Drawings.
 5. Operating instructions.
 6. Recommended maintenance procedures.
 7. Lists of major items of equipment with name, address, and telephone number of each local representative.
- C. Submit the manuals for approval at approximately 75 percent job completion.

1.21 RECORD DRAWINGS:

- A. Accumulate Record Drawings during the construction of the Project. Keep one set of blueline Contract Drawings at the job site at all times, and mark changes, rerouting or modifications which occur, clearly on the Drawings with dimensions.
- B. At completion of the job, deliver Record Drawings to Architect. Record Drawings shall be submitted for approval prior to final payment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer's names and catalog numbers are scheduled or specified for the purpose of establishing standard of design, quality, appearance, performance and serviceability, and not to limit competition. Scheduled products (as may be modified by detailed specifications) are those selected as the basis for system design with respect to physical size and space arrangements, required capacity and performance characteristics, and the product quality intended.
- B. The Drawings indicate specified products physically arranged in the spaces, as cataloged by specific manufacturers, generally as listed in the Equipment Schedules.
- C. Listed "Acceptable Manufacturer's" are those considered capable of manufacturing products conforming to detailed Specifications, and as such, are invited to compete on an equal basis provided the offering is comparable in every respect to scheduled or specified products and actually conforms to the detailed Specifications and Schedule requirements. Listing herein as "acceptable manufacturers" does not imply "accepted", "approved", or "prior approval", or any other such connotation.
- D. Vendors are invited to submit material or equipment bids to bidding Contractors on any comparable equivalent product, whether or not the manufacturer of such product is listed herein as an "acceptable manufacturer". Such product bids should clearly indicate offerings that are not listed as "acceptable manufacturer's". In the event a bidding Contractor, after satisfying himself that such unlisted product is in fact "equal" to the specified product with respect to design, quality, performance and arrangement (space requirements), and the Contractor desires to furnish that product on the Project, he may request the name of the manufacturer be added to the list of acceptable manufacturers by addendum prior to bid time.

- E. At a bidder's request, an unnamed manufacturer's equipment will be considered to determine additional "acceptable manufacturers" if a request is made in writing no later than ten days prior to the bid opening. If such requests are found acceptable, an addendum will be written listing additional acceptable manufacturers. Consideration will be given only to requests of bona fide bidders (Contractors), not to those received from vendors.
- F. Manufacturers of materials and equipment shall be as specified, scheduled, or as listed in each respective product Specification Article.

2.2 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS:

- A. Materials and adhesives used throughout the electrical systems shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke developed rating not higher than 50. If such materials are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating not higher than 50. (Note: materials need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard or where specifically exempted in the body of these Specifications).
- B. "Flame Spread Rating" and "Smoke Developed Rating" shall be as determined by the "Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255, ASTM E84, Underwriters Laboratories, Inc., Standard". Such materials are listed in the Underwriters Laboratories, Inc. "Building Materials List" under the heading "Hazard Classification (Fire)".

2.3 SLEEVES AND ESCUTCHEONS:

- A. Generally, where conduits pass through walls or floors, 22 gauge galvanized sheet iron sleeves shall be used, except those in beams, outside walls, or structural walls or members which shall be standard galvanized steel pipe. The size of these sleeves shall be such as to permit readily the subsequent insertion of conduit of the proper size with adequate clearance for movement due to expansion and contraction. Where conduits pass through outside walls, the inside diameter of the galvanized iron pipe sleeves shall be at least 1/2" greater than the outside diameter of the service pipe. After the conduits are installed, fill the annular space between the conduit and its sleeve with a mastic or caulk with lead. Use packing as required to accomplish this.
- B. Sleeves in existing masonry load bearing walls shall be schedule 40 steel pipe grouted in place with structural grout. For exterior walls, the space between the pipe and the sleeves shall be packed with oakum or jute twine and calked watertight.
- C. Escutcheons, except as specifically noted or specified, shall be installed on all conduits passing exposed through the floors, walls, or ceilings. Escutcheons shall be equal to the Crane No. 10 chrome plated sectional floor and ceiling plates and shall fit snugly and neatly around conduit. Solid chrome plates with set screws shall be used if sectional plates do not fit properly or stay in place.

2.4 FIRE STOPPING:

- A. Seal annular spaces between sleeves and penetrating materials in fire rated floors, ceilings, and walls with fireproof and waterproof silicone elastomer applied in accordance with the manufacturer's published instructions. Multiple penetrations shall be sealed with silicone caulking. Seal material shall be UL classified for use in fire rated penetration seals, and shall be applied in the manufacturer's recommended thickness for the fire rating of the penetrated structure in accordance with ASTM-E-814 requirements.
- B. Acceptable Manufacturers - Dow Corning, General Electric, Hilti.

2.5 WATERPROOFING:

- A. Seal penetrations of wet or potentially wet structures, floors, exterior walls, etc., other than those requiring fire stopping, with sealant to prevent moisture leakage. Apply sealing material (caulking) in accordance with manufacturer's published instructions.
- B. Product Research and Chemical Co. "Poly-Sulphide Sealant" PRC- 5000.

2.6 CABINETS:

- A. Provide cabinets where indicated and where necessary.
- B. Provide flush type in finished areas centered in paneling and other Architectural features.
- C. Provide surface type in equipment rooms, above accessible finished ceilings, and in crawl spaces.
- D. Install lighting and power cabinets with tops 6 feet 6 inches above finished floor.
- E. Cabinets for Panelboards shall be of same manufacturer as panelboard interiors. Cabinets for timeclocks, contactors and other electrical equipment supplied under this division may be of other manufactures complying with NEMA, UL and nec requirements. All boxes shall be code gauge steel, welded with edges turned to receive trim, and galvanized. Trim and doors shall be No. 12 gauge steel minimum, hinged door, flush tumbler lock and catch keyed alike throughout the work, factory enamel finish, suitable for field color coat. For flush panels provide covers with overlap minimum 3/4 inches top, bottom, and sides. For surface mounted panels covers shall be same size as cabinet.
- F. Identify all cabinets for all panelboards, switchboards, disconnect switches, transformers, motor starters, and electrical equipment furnished shall be provided with engraved phenolic lamacoid plastic name plates with 1/2 inch block engraving. Name plates shall give equipment designation as scheduled on the drawings and voltage and phase of service.

2.7 GROUNDING:

- A. Provide grounding of electrical system in accordance with the National Electrical Code NFPA 70, UL 467, and IEEE 837 for grounding and bonding materials and equipment.

1. Equipment grounding conductors shall be sized in accordance with the National Electrical Code Equipment Grounding Conductor Table on the basis of the circuit overcurrent protection device rating.
 2. Bond together the following items to serve as a single grounding electrode for all electric services:
 - a. Minimum 20 feet BHD copper conductor encased in concrete footing or grade beam in contact with earth.
 - b. Structural steel building framework.
 - c. 10'-0" X 3/4" diameter copper-clad steel ground rod(s).
 - 1) Where more than one ground rod is required to meet specified resistance, ground rods shall be located at least 10 feet apart. Interconnect with grounding electrode conductor below grade unless otherwise indicated.
 - d. Metal underground water pipe.
 3. The grounding electrode shall be connected by a grounding electrode conductor sized in accordance with the National Electric Code Table 250-94 to the service neutral bus.
 4. Provide a main bonding jumper from the grounded service neutral bus to the main equipment ground bus or point of termination of the equipment grounding conductors.
 5. Provide bonding jumpers for attachment of each metallic water, fuel, fire suppression, steam, gas or air piping system to the building grounding electrode system. Provide connections with listed connectors applied to the piping in an approved method. The points of attachment of the bonding jumpers shall be accessible. The bonding jumper size shall match the main grounding electrode conductor.
 6. Grounding system resistance must not exceed 5 ohms. Final tests shall be conducted to ensure that this requirement is met.
- B. Provide equipment grounding conductors for all circuits. A green insulated, copper ground conductor shall be installed with all circuits so as to make an electrically continuous ground system.
- C. Ground all non-current carrying equipment, such as cable tray and equipment structures.
- D. Grounding Connectors:
1. Listed and labeled by a NRTL acceptable to the authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
 2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
 3. Welded Connections:
 - a. Exothermic welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
 - b. For structural steel, steel grounding stud for compression connector.
 4. Compression Connectors: Hydraulic crimped, irreversible compression type kits. Connectors shall be factory filled with oxide inhibitor. All crimps shall be made with a hydraulic tool that embosses the index number on the outside of the connector. Compression type connections shall be allowed above and below grade where any permanent connection is required.

5. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

E. Field Quality Control

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation. Inspect compression type connections for proper die index number embossment.
2. Perform the following testing:
 - a. After installing grounding system, but before permanent electrical circuits have been energized, test for compliance with requirements.
 - b. Test completed grounding system as each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at ground rods. Make tests at ground rods before any conductors are connected.
 - c. Measure ground resistance no fewer than two full days after the last trace of participation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - d. Perform tests for fall-of-potential method according to IEEE 81. Submit test results to the Engineer.
 - e. If resistance to ground exceeds specified values, promptly notify Engineer and include recommendations for reducing ground resistance.

2.8 IDENTIFICATION:

- A. Provide engraved phenolic lamacoid plastic name plates with 1/2 inch block engraving. Name plates shall give equipment designation as scheduled on the drawings.
- B. After balancing branch circuits, provide each breaker panel with a typed directory which identifies specifically the branch circuit loads and location. Use architectural room names and designations found on the Contract Documents.
- C. Provide labels for fused switches indicating equipment served and unit capacity in horse power or full load amperes and the installed fuse rating.

2.9 WIRE AND CABLE:

- A. Provide systems of wires and cables for electric power, signalling, and control.
- B. Materials:
 1. Conductors shall be soft drawn annealed, conductivity of 98% pure copper. No. 10 AWG and Smaller: Solid copper. No. 8 AWG and Larger: Stranded copper.
 2. Other: Pull Cords - 1/8" nylon. Pulling Compound - Ideal "Yellow 77".
- C. Install Wire Types:
 1. THHN/THWN, XHHW for light and power branch circuits and control wiring.

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2. THHN/THWN, XHHW for feeders, sub-feeders, motor circuits and high ambient temperature locations.
- D. Consistently color code wiring continuous throughout the work with insulation factory color-coded by pigmentation.
1. 120/208 Volt Systems:
 - a. Phase A - Black
 - b. Phase B - Red
 - c. Phase C - Blue
 - d. Neutral - White
 - e. Ground - Green
 2. 277/480 Volt Systems:
 - a. Phase A - Brown
 - b. Phase B - Orange
 - c. Phase C - Yellow
 - d. Neutral - Gray
 - e. Ground - Green
 3. Switch legs, travelers, and special systems continuous throughout the work as selected by the Contractor.
 4. Where factory colors are not available, code ends of conductors with 1-1/2 inch colored tape.
- E. Circuits of multiple phases passing through enclosures shall have phases grouped to reduce the reactance effect.
- F. Minimum Sizes:
1. Light and Power Branch Circuits, 15 and 20 amperes OCP:
 - a. Minimum branch circuit: No. 12 AWG
 - b. 120V longer than 80 feet first outlet to panel: No. 10 AWG.
 - c. 120V longer than 120 feet from first outlet to panel: No. 8 AWG
 - d. 277V longer than 130 feet from first outlet to panel: No. 10 AWG.
 - e. 277V longer than 220 feet from first outlet to panel: No. 8 AWG.
 2. All branch circuits shall have dedicated full ampacity neutrals, or shared neutral conductors serving two or three branch circuits shall be sized at 175% of the maximum branch circuit overcurrent device, based on the 75°C ratings in Table 310-16 of the National Electrical Code. Shared neutral conductors shall be considered as current-carrying conductors for the purpose of derating conductor ampacities for installation of more than three current-carrying conductors in a raceway or cable.
 3. Other circuits sized to limit voltage drop per National Electrical Code.
 4. Control Wiring: No. 14 AWG, unless otherwise specified.
- G. Acceptable Manufacturers - American Insulated Wire Corp., Cablec Corp., Cerrowire, Essex, Guardian, Rome Cable, Triangle.

2.10 OUTLET BOXES:

- A. Provide outlet boxes for the installation of wiring devices, lighting fixtures, fire alarm devices and power and control connections. Provide boxes at the terminal of conduit runs to outlets and devices and for installation of conductors as required by the NEC.
- B. Locate switch boxes at locations designated by Architectural Documents when indicated. If Architectural locations are not identified use appropriate locations consistent with schematic indications on Electrical Documents. Where application of switches repeats installation type and relative locations shall be consistent throughout project unless indicated otherwise.
- C. Provide standard manufactured plugs in unused openings of boxes. Provide plaster rings and covers where required by the building structure. Rigidly attach boxes to structure and ceiling supporting members in suspended ceilings to avoid cutting mechanical ceiling members.
- D. Materials: Metallic boxes shall be of welded or one piece cast construction.
 - 1. Flush Mounted Outlet Boxes: Standard, stamped galvanized steel with factory conduit knockouts, one piece and welded construction.
 - 2. In dry walls for single and two gang outlet provide 4S and 4D boxes, for 3 or more outlets use masonry boxes.
 - 3. In block and masonry walls provide masonry boxes of depths required for wall thickness.
 - 4. In ceilings provide 4 inch boxes. Omit covers if standard canopy and device plates entirely cover the ceiling opening.
 - 5. In exposed work, exterior of the building, in wet locations, and flush in non-waterproofed walls below grade provide FS and FD boxes.
 - 6. Unless instructed otherwise on drawings, for telephone and data outlets, provide empty flush mounted wall box with 3/4-inch conduit in wall to accessible ceiling space.
 - 7. See scheduled flush floor boxes on drawings.
- E. Location: Install center of box at heights above finished floor unless other directions are indicated in Contract Documents:
 - 1. Wall Switches: 47 Inches
 - 2. Convenience Outlets: 18 Inches
 - 3. Telephone/Data Outlets: 18 Inches
 - 4. Boxes Indicated Above Counters (CT): 6 Inches above backsplash and trim, unless otherwise indicated.
- F. Do not use through-the-wall and back-to-back boxes.

2.11 WIRING DEVICES:

- A. Samples: Provide two samples of each type and color of wiring device and respective cover plate utilized in the project. Provide other samples upon specific request for typical NEMA devices. Colors of all exposed devices shall be as herein specified, and shall be submitted for final approval by Architect.
- B. Cover Plate and Wiring Device colors:
 - 1. Finished areas: Grey devices with stainless steel cover plates.

2. Maintenance and equipment rooms: Grey devices and galvanized steel coverplates.
- C. Cover Plates for Telephone and Data Boxes: Blank, brushed stainless steel, unless otherwise noted on plans.
- D. Weatherproof Cover Plates: Corrosion resistant finish metal plate, die cast cover, and gasket.
- E. Cover Plates for Surface Mounted Outlet Boxes: Zinc coated sheet steel rounded edges, same size as outlet box.
- F. Wiring Device Schedule (Based on Leviton Specification Grade) -
 1. Standard duplex receptacle - 125V, 20A, NEMA 5-20: #5352.
 2. Special receptacles - type and NEMA configuration as indicated on drawings.
 3. Ground fault circuit interrupting duplex receptacle - 125V, 20A, NEMA 5-20: #6898.
 4. One pole wall toggle switch - 120/277V, 20A: #1221-2.
 5. Two pole wall toggle switch - 120/277V, 20A: #1222-2.
 6. Three-way wall toggle switch - 120/277V, 20A: #1223-2.
 7. Four-way wall toggle switch - 120/277V, 20A: #1224-2.
 8. Special switches - As indicated on plans.
 9. Acceptable Manufacturers - Eagle, Hubbell, Leviton, Pass and Seymour.

2.12 CONDUITS:

- A. Provide a mechanically and electrically complete conduit system.
- B. Rigid Metal Electrical Conduit: Hot-dipped galvanized steel with zinc coated threads and an outer coating of zinc bichromate, complete with one coupling and one end thread protector.
- C. Intermediate Metal Conduit: Hot-dipped galvanized steel, complete with one coupling and one end thread protector.
- D. Electrical Metallic Tubing: Welded, electro-galvanized thin wall steel tubing.
- E. Flexible Metal Electrical Conduit: Hot-dipped galvanized steel strip core with integral copper ground wire on sizes 1-1/4" and smaller.
- F. Liquidtight Flexible Metal Electrical Conduit: Hot-dipped galvanized steel strip core with extruded polyvinyl jacket, O-Z Gedney Type UAG.
- G. Rigid Nonmetallic Electrical Conduit: Schedule 40 heavy wall polyvinylchloride, high impact resistant.
- H. Elbows and Bends:
 1. For rigid nonmetallic conduit systems, use rigid metal electrical conduits.
 2. For other conduit systems, use same material as the conduit with which they are installed.
 3. For all types, size 1-1/4 inch and larger shall be factory manufactured.
- I. Bushings:

1. 1-1/4" and Smaller: Same material as the conduit with which they are installed.
 2. 1-1/2" and Larger: Hot-dipped galvanized with thermosetting phenolic insulation, 150 Deg.C., O-Z/Gedney Type "B".
- J. Locknuts:
1. 1-1/2" and Smaller: Zinc plated heavy stock steel, O- Z/Gedney.
 2. 2" and Larger: Cadmium plated malleable iron, O-Z/Gedney.
- K. Hubs: Cadmium plated malleable iron, tapered threads, neoprene "O" ring, insulated throat, O-Z/Gedney.
- L. E.M.T. Fittings:
1. Compression Connectors and Couplings: Gland compression type, die cast zinc body, malleable iron nut, insulated throat, O-Z/Gedney, Raco, Red Dot.
 2. Set Screw Connectors and Couplings: Die cast zinc body, single set screw for 1/2" - 1" sizes, two set screws for 1 1/4" - 4" sizes, O-Z/Gedney, Raco, Red Dot.
- M. Liquidtight Conduit Connectors: Cadmium plated malleable iron body and nut, cadmium plated steel ferrule, insulated throat, integrally cast external ground lug, O-Z/Gedney Type 4QL.
- N. Seals for Wall and Floor Penetrations: Malleable iron body, oversize sleeve, sealing ring, pressure clamp and rings and sealing grommet, hex head cap screws, O-Z/Gedney Type FSK.
- O. Fire Seals: Heat activated intumescent material, elastomeric sealing ring, socket head cap screws, steel pressure discs and flange, O-Z/Gedney Type CFSF.
- P. Expansion Fittings: Hot-dipped galvanized malleable iron with bonding jumpers.
- Q. Escutcheons: Chrome plated sectional floor and ceiling plates, Crane No. 10.
- R. Accessories: Reducers, bushings, washers, etc., shall be cadmium plated malleable iron on the forms and dimensions best suited for the application.
- S. Size conduits as indicated on the drawings and as required by the NEC for the number and sizes of wires to be drawn into conduit. Do not use conduit sized less than 3/4" unless specified otherwise.
- T. Conceal conduits from view in all areas except mechanical and electrical equipment rooms, attics and crawl spaces.
1. Should it appear necessary to expose any conduit, bring specific information to the attention of the Architect immediately, and rearrange the work to facilitate an approved installation.
 2. Where conduits must be exposed in finished areas, utilize paintable surface mounted vinyl or metal raceways, fittings and boxes equivalent to Wiremold or Hubbell. No exposed circuitry shall be installed in finished spaces without prior approval of Architect.
- U. Installation:

1. Install all conduits at elevations and locations to avoid interference with grading of other work, the structure, finished ceilings, walls. Avoid causing cutting of masonry units.
2. Install conduits before concrete is placed, and in advance of masonry work. Run conduits imbedded in structural slabs in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum 1-1/2" cover except where penetration is made. Do not install conduit larger than 1" in slabs.
3. Install conduits through roof in time to be flashed prior to roofing application.
4. Cap or plug conduits with standard manufactured accessories as soon as the conduits have been permanently installed in place.
5. Where space conditions prohibit the use of standard ells, elbows, and conduits, use cast ferrous alloy fittings of such forms and dimensions as best required for the application.
6. Make all conduit joints mechanically tight, electrically continuous, and watertight. Pitch conduits in a manner to avoid creating moisture traps.
7. Connect and couple E.M.T. with compression or set screw type fittings. Do not use indentor fittings.
8. Install and neatly rack exposed conduits parallel with and perpendicular to the building walls. Do not install exposed diagonal conduit runs.
9. Do not run conduits exposed on the roof unless approval is obtained prior to installation.
10. Do not place conduits in close proximity to equipment, systems, and service lines, such as hot water supply and return lines, which could be detrimental to the conduit and its contents. Maintain a minimum 3" separation, except in crossing, which shall be a minimum 1".
11. Connect motors, equipment containing motors, equipment mounted on an isolated foundation, transformers, and other equipment and devices which are subject to vibration and which require adjustment with flexible metallic conduit from the device to the conduit serving it. Size the flexible conduit length more than 12 diameters, but less than 18 diameters. Rigidly support the points of attachment on each side of the connection. Use external bonding jumpers on sizes 1-1/2" and above.
12. Install escutcheons on all exposed conduits passing through interior floors, walls, or ceilings. Install fire seals on all conduits passing through fire rated partitions. Install wall and floor fire seals on all conduits passing through exterior walls and floors, or use standard galvanized steel pipe sleeves; diameters 1/2" greater than the outside diameter of the sleeved conduit and fill the annular space with mastic.
13. Install rigid metal electrical conduit for feeders and sub-feeders, and for all used in damp and wet locations and in hazardous areas.
14. Install electrical metallic tubing for branch circuits concealed in walls and above ceiling for size 2" and smaller.
15. Install rigid non-metallic conduit with manufactured spacers for feeders and branch circuits run underground exterior to the building, or underground and beneath the building, or where specifically noted. Use rigid metal conduit long radius sweeps for offsets and changes in direction. Use rigid metal conduit for risers and where exposed above slab or grade.
16. Install flexible metal conduit where specified above and where permitted by the authorities having jurisdiction for final connections to lighting fixtures which have isolated junction boxes. Use liquid-tight flexible conduit for exterior applications, in damp and wet locations.
17. Install pull cords in all empty raceway systems, tagged with the identification of service intended and location of opposite end.

2.13 ACCESS DOORS:

- A. Furnish, for installation under appropriate Section of the Work, access doors at each point required to provide access to concealed valves, dampers, damper operators, and other devices requiring operation, adjustment, or maintenance.
- B. Shall be 16 gage steel, with mounting straps, concealed hangers, and screwdriver locks, designed for the doors to open 180 degrees, minimum.
- C. Access doors installed in fire walls or partitions shall be UL labeled to maintain surfaces.
- D. Provide prime coat finish for installation in ceilings or painted or unfinished surfaces.
- E. Provide polish chrome plate finish for installation in unpainted finished walls.
- F. Acceptable Manufacturers - Baldwin, Hannon, Josam, Miami, Carey, Milcor, Titus, Wade, Walsh, Zurn.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT:

- A. Protect equipment from physical damage and deterioration after it is delivered to the Project, and during the installation period prior to Owner acceptance. Repair scratches, mars, or paint deterioration.

3.2 EQUIPMENT SPACE:

- A. The Drawings indicate specified products physically arranged in the spaces, as cataloged by specific manufacturers, generally as listed in the Equipment Schedule.
- B. Coordinate the exact physical space requirements for equipment and servicing of equipment actually purchased for each item of equipment involved.
- C. Keep horizontal lines as close to ceiling as practicable.
- D. Adhere to Drawings as closely as possible in layout of work.
- E. Vary run of conduits and make offset during progress of work as required to meet structural and other interferences.
- F. Install conduits in furred spaces wherever possible. Run exposed conduits parallel to or at right angles to buildings walls.
- G. Conform to ceiling heights established on architectural construction drawings.

3.3 INTERFERENCES:

- A. Relocate or reroute existing conduit, wiring, or equipment as required to facilitate construction of finished work as planned. Restore surfaces, insulation, and finish to match condition of adjacent work.

3.4 CUTTING AND PATCHING:

- A. Assume costs and responsibility for cutting and patching required to complete the installation. Patching shall be finished to match adjacent surfaces to the satisfaction of the Architect.

3.5 PAINTING AND FINISHING AND CLEANING:

- A. Provide touchup painting of prefinished electrical products.
- B. Surfaces shall be left clean and debris shall be removed.
- C. Clean all light fixture lenses, lamps and reflectors.

3.6 OPTION TO RELOCATE OUTLETS AND RELATED DEVICES:

- A. Electrical outlets and light fixtures may be relocated at the Owner's option to points within 10-feet of their indicated locations, at no additional cost to the Owner, provided the Contractor is notified prior to roughing-in and fabrication.
- B. Only work which must be reperformed in this connection will be considered extra.

3.7 TESTS AND LOAD BALANCING:

- A. Test all circuits to assure them to be free of grounds. Prove and test energy available at the load side of disconnect switches and the final point of connection to driven equipment. Make all reasonable tests as required by the Architect to provide the integrity of the work and leave the complete electrical installation in first class condition and ready for operation.
- B. Balance the load on each phase when connecting the various branch circuits in each panel board. When all load is turned on and the system is in operation at 100% demand, the initial unbalance shall not exceed 10%.
- C. Furnish at the completion of the job, a final inspection certificate from the local inspecting authority.

3.8 ELECTRICAL DISCONNECTS:

- A. Provide disconnects where indicated and where required by the National Electrical Code. Install within sight of electrified equipment served and provide final connection to equipment served.
- B. Provide switch sizes as required by the National Electrical Code based on the equipment actually furnished under other Divisions or provided by the Owner.

- C. Provide NEMA 1 enclosure indoors, NEMA 3R enclosure exterior, in damp or wet locations and in crawl spaces, flush and surface as specified for outlet boxes.

3.9 EQUIPMENT CONNECTIONS:

- A. Provide wiring for the connection of motors and control equipment and control wiring as indicated on the Electrical Drawings.
1. Equipment installed under Other Sections - wiring shall be extended to the equipment, and proper connections made thereto.
 2. Flexible connections of short lengths - shall be provided for equipment subject to vibration or movement and for motorized and compressor equipment. Liquid-tight conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.

3.10 EXCAVATION AND BACKFILLING:

- A. Provide necessary excavating and backfilling for the installation of work specified in this Division. Trenches for underground conduits shall be excavated to required depths as necessary to insure uniform bearing. Care should be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below the lowermost part of the raceway and refilled to the raceway grade as specified. After the raceway has been installed, tested, and approved, the trenches shall be backfilled to grade with approved material, in 12 inch layers wetted and compacted to density of adjacent soil. Complete backfill to grade to result in a well compacted trench to 95% compaction by the standard Proctor test. Where streets, sidewalks, etc., are disturbed, cut, or damaged by this work, the expense of repairing same in a manner approved by the Architect shall be a part of this work.

END OF SECTION 26 01 00

SECTION 26 16 00 - POWER DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide distribution panelboards, branch circuit panelboards, motor control centers, transformers and power factor correction equipment, as scheduled and specified for the electrical distribution system.

1.2 QUALITY ASSURANCE:

- A. Source Quality Control: Tests to meet applicable standards of the following:
 - 1. Underwriters' Laboratories.
 - 2. National Electrical Manufacturer's Association.
 - 3. National Electrical Code.
 - 4. American National Standards Institute.

1.3 SUBMITTALS:

- A. Submit shop drawings in accordance with other Sections. Include layouts showing cabinet dimensions, conduit entrances, electrical ratings, bussing connections, single line diagrams, device locations and ratings, and cable termination provisions.
- B. Certificates:
 - 1. Labels of Underwriters' Laboratories affixed to each item of material.
 - 2. Label of Underwriters' Laboratories approval for service entrance use, where applicable, affixed to material.
- C. See section 26 01 00.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION EQUIPMENT:

- A. Branch Circuit Panelboards:
 - 1. Equivalent to Square D Type NQ and NF, all bussing - copper.
 - 2. Single phase, 3 wire, and 3 phase, 4 wire, solid neutral design with sequence bussing and full capacity neutral.
 - 3. Provide scheduled circuit breakers, minimum 10,000 A.I.C. for 208 volt and 14,000 for 480 volt.

4. Provide feed thru lugs where extension of primary feeders is required.
5. Provide cabinets of NEMA type appropriate for application.
6. Provide isolated ground bus where scheduled.

B. Circuit Breakers:

1. Resettable, quick-make, quick-break, thermal magnetic type, ambient compensated, trip free with separate trip position from on and off positions.
2. Multiple pole breakers with common trip and one operating handle. Do not provide handle ties.
3. 15 and 20 ampere, single pole circuit breakers shall be U.L. listed as switching duty rated.
4. Wire with sequence phasing.
5. Provide circuit breakers of appropriate capacity for all unscheduled circuits.
6. For panelboards rated 600 amperes or greater, provide bolt- on type circuit breakers.
7. Provide U.L listed HACR circuit breakers for compressorized equipment loads where the circuit breaker serves as the final overcurrent protection.
8. Where indicated on the panel schedule, provide panel mounted power supply to provide 24 volts DC switching power for remote controlled circuit breakers.
9. Breakers indicated to be "Remote Controlled":
 - a. Circuit breakers shall be UL Listed and rated 120/ 240Vac (1- and 2-pole) and 240Vac (3-pole) with continuous current ratings as shown on the plans.
 - b. Circuit breakers shall have an overcenter, trip-free, toggle type, quick-make/quick-break mechanical action and positive handle indication. Handle shall have on, off, and tripped positions. In addition, trip indication shall include a trip indicator on the face of the breaker case.
 - c. Multi-pole breakers shall have internal crossbars for common trip operation.
 - d. Circuit breaker contacts shall be open when breaker is in the OFF or "tripped" position regardless of remote signal.
 - e. Interrupting capacity shall be 10,000 rms symmetrical amperes.
 - f. 15A and 20A breakers shall be SWD rated.
 - g. Multipole circuit breakers rated 15-60A shall be UL Listed for HACR applications.
 - h. All circuit breakers shall have contacts suitable for use on HID lighting systems.
 - i. Circuit breakers shall be marked "Remote Controlled" in such a way that the marking is visible with the trim installed.
 - j. Circuit breakers shall have terminals suitable for use with Al/Cu 75°C wire.
 - k. Circuit breakers shall be capable of operating for 30,000 operations at rated voltage and current with an 80% lagging power factor.
 - l. Remote-control shall be accomplished via a 24Vdc high speed motor with clearing switch that clears the motor circuit upon circuit breaker contact opening or closing.
 - m. Motor shall operate no more than 50 milliseconds at rated voltage (24Vdc) $\pm 10\%$ and draw no more than 2A instantaneous. Maintaining the control signal shall have no adverse effect on the breaker.

C. Enclosed Circuit Breakers:

1. Equivalent to Square D LHL, MHL and PJJ.
2. 3 phase, 4 wire, solid neutral design with sequence bussing, copper and full capacity neutral unless scheduled otherwise.

3. 65,000 Amp., R.M.S. minimum interrupting rating, or as scheduled on drawings.
4. Provide dual rated lugs for supply and load conductors.
5. Provide cabinets of NEMA type appropriate for application. Outdoor enclosures shall be equipped with factory installed means to padlock door.
6. Weather proof hubs and threaded conduit connections shall be used for outdoor circuitry.
7. Provide ground bus unless noted otherwise.

D. Dry Type Transformers:

1. Two windings of the size and electrical characteristics as scheduled.
2. Guaranteed sound levels shall not exceed ANSI standard decibel levels. Transformers shall be rated at full load in a 40°C ambient with 30°C ultimate hot spot temperature rise allowance, with Class F insulation having a UL 185°C rating limiting system temperature to 115°C on 25 kVA and smaller units, and Class H insulation having a UL 220°C rating limiting system temperature to 150°C on 30 kVA and larger units.
3. The maximum temperature rise of the top of the enclosure shall not exceed 35°C over a 40°C ambient.
4. Transformers rated at 30 kVA and above shall have core and coil assembly completely isolated from enclosure with neoprene rubber pads, and six primary voltage taps rated (4) 2-1/2 percent normal and (2) 2-1/2 percent above normal. Transformers rated at 25 KVA and below shall have four primary voltage taps rated (2) 2-1/2 percent below normal and (2) 2-1/2 percent above normal.
5. Make necessary tap adjustments on transformers to insure that the secondary voltages at the transformer terminals will be as close as possible to 120 volts phase-to-neutral, and 208 volts phase-to-phase, when the building is in normal operation.
6. Transformers shall have heat barriered termination compartment arranged for feeder terminations for side or bottom entrance of flexible metallic raceways.
7. Transformers shall have a bonding jumper installed between the secondary neutral terminal and the metal case and shall include a ground terminal of proper size to receive ground conductor.

E. Acceptable Manufacturers – Eaton, General Electric, Siemens, Square D.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Carefully measure and lay out exact locations of equipment in conference with the Construction Manager.
- B. Assure that equipment may be installed without adversely affecting the integrity and appearance of the building structure and with the clearances required by the National Electrical Code.

3.2 INSTALLATION:

- A. Provide panelboards of the types and ratings scheduled where indicated.
- B. Provide flush and surface mounted types where indicated and scheduled.

1. Provide multi-section cabinets as required and scheduled; one-piece covers and doors, main and sub-feed lugs as required.
 2. Provide hinged doors with flush tumbler lock and catch, all locks keyed alike.
 3. Provide 3 keys for each panelboard.
- C. Provide supports to the building structure, independent of raceways.
- D. Install tops of panelboard cabinets at 6 feet, 6 inches, above finished floor.
- E. Install panelboards in cabinets, centered in door openings.
- F. Provide Identification:
1. For Panelboards - Engraved, lamacoid plastic name plate, giving equipment designation.
 2. For Distribution and Branch Circuit Panelboards: - Neatly typewritten circuit directory in cardholder inside panelboard door.
 - a. For Branch Circuit Panelboards: Identify rooms served using room numbers corresponding to those finally established at the project.
 - b. For Distribution Panelboards: Identify the equipment served and give circuit designation.
 - c. For motor starters identify equipment designation as scheduled on the drawings, voltage and phase of service, and the source of power.
- G. Provide Vibration Isolation for Suspended Transformers:
1. Provide spring hangers, equivalent to Mason Type PC30, 1" deflection, consisting of a rectangular steel box, coil spring, spring cups, neoprene impregnated fabric washer, and steel washer, with an elastomeric element at the top of the box for acoustic isolation. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall be designed for approximately 1/4-inch deflection and loaded so that deflection does not exceed 15 percent of the free height of the element.
 2. Install the isolators with the isolator hanger box as close as possible to the structure.
 3. Suspend the isolators from the building structure, never from slab diaphragms between beams.

3.3 FIELD QUALITY CONTROL:

- A. Perform manufacturer's recommended field tests prior to energization.
- B. Provide copies of test results to the Owner's representative.

END OF SECTION 26 16 00

SECTION 26 17 00 - MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.1 SCOPE

- A. Provide disconnect switches for branch circuit, motor circuits, and all items of equipment in conformance with the National Electric Code.

1.2 QUALITY ASSURANCE

- A. Source Quality Control: Tests to meet applicable Underwriters' Laboratories, Inc. Standards, the National Electrical Manufacturer's Association and the National Electrical Code.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with other Sections. Include enclosure dimensions, type, electrical ratings, fuse provision, installation instructions, and name plate nomenclature.
- B. Certificates:
 - 1. Labels of Underwriters' Laboratories, Inc. affixed to each item of materials.
- C. See Section 26 01 00.

1.4 JOB CONDITIONS:

- A. Provide switch sizes as required by the National Electrical Code based on the equipment actually furnished under other Divisions or provided by the Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. For single phase motors under 1/2 horsepower: Equivalent to Square D Class 2510 Fractional Horsepower single phase two pole manual starter with toggle type switch, locking attachment, neon pilot light, thermal overload elements sized per motor name plate rating and NEMA 1 enclosure indoors, NEMA 4 enclosure exterior, in damp or wet locations and in crawl spaces, flush and surface as specified for outlet boxes.

- B. For single and three phase motors, 120, 230, 480 volts, 1/2 to 3 horsepower, requiring manual starters: Equivalent to Square D Class 2510 Integral Horsepower manual starter with toggle type switch, low voltage protection, pilot light, thermal overload elements sized per motor name plate rating with number of poles required for specific application and NEMA 1 enclosure indoors, NEMA 3R enclosure exterior, in damp or wet locations and in crawl spaces, flush and surface as specified for outlet boxes.
- C. For Other 250 Volt Equipment: Equivalent to Square D Class 3130 NEMA Type GD Safety Switches, fusible and non-fusible as required by NEC with cover interlocks, with NEMA cabinet required for application, with threaded hubs.
- D. Acceptable Manufacturers - Cutler Hammer, General Electric, Siemens ITE, Square D.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect building structure to which disconnects are to be secured for defects which affect the execution and quality of work.
- B. Do not start work until defects are corrected.

3.2 PREPARATION

- A. Carefully measure and lay out exact locations maintaining working clearances required by the National Electrical Code.

3.3 INSTALLATION

- A. Provide disconnects where indicated and where required by the National Electrical Code.
- B. Install within sight of equipment served.
- C. Provide final connection to equipment served.
- D. Provide name plate secured to cabinet with designation of equipment served, operating voltage, and circuit designation.

3.4 EQUIPMENT CONNECTIONS

- A. Provide wiring for the connection of motors and control equipment and control wiring as indicated on the Electrical Drawings.

1. Equipment installed under Other Sections - wiring shall be extended to the equipment, and proper connections made thereto.
2. Flexible connections of short lengths - shall be provided for equipment subject to vibration or movement and for motorized and compressor equipment. Liquid-tight conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.
 - a. Length of flexible connections for motors shall be at least 11-inches plus 1/4-inch per horsepower up to 100 hp, and need not be longer than 36-inches unless otherwise indicated.
 - b. Length of flexible connections for transformers shall be at least 11-inches plus 1/4-inch per KVA up to 100 KVA, and need not be longer than 36-inches unless otherwise indicated.
3. Power connections to any vibration isolated equipment shall be made with a length of flexible conduit having a 90 degree bend in it between the junction box on the equipment and any non-flexible conduit.
4. Owner furnished equipment - wiring shall be extended to the equipment, and proper connections made thereto.

END OF SECTION 26 17 00

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Conditions of the Contract and General Requirements are hereby made a part of this section.
- B. Provide lighting fixtures, lamps, and accessories for interior and exterior illumination of the building.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Exceptions to manufacturers listed with each item shall be made in accordance with the General Requirements.
- B. Laboratory Testing: Photometric testing shall be by Independent Testing Laboratories, Inc., based on Illuminating Engineering Society published procedures, and shall include candlepower distribution tabulation and zonal cavity coefficient of utilization tabulation.
- C. Standards:
 - 1. All lighting fixtures shall meet Underwriters' Laboratories, Inc., applicable standards.
 - 2. Fixtures shall be provided possessing Underwriters' Laboratories location duty listings as required by the specific application.
 - a. Exposed Outdoors - Wet Location
 - b. Sheltered Outdoors - Damp location
- D. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.
- F. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.
- G. UL Compliance: Provide light fixtures that have been UL listed and labeled.

1.3 SUBMITTALS:

- A. Submit manufacturer's literature giving materials, finishes, dimensions, coefficients of utilization, and lamp types for each fixture which is the product of one of the listed acceptable manufacturers.

- B. Submit samples of fixtures upon specific request.
- C. See Section 26 01 00.

1.4 CERTIFICATES:

- A. Labels of Underwriters' Laboratories, Inc.; Certified Ballasts Manufacturers, and Electrical Testing Laboratories affixed to each item of material.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FIXTURE MANUFACTURERS:

- A. Listed in schedule and with materials.
- B. Substitutions: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. Copies sent via facsimile or e-mail will not be accepted. After review of the proposed substitute fixtures, an addendum may be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures of other manufacturers. The Architect/Engineer shall have the final authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item

2.2 LED LIGHT FIXTURES:

- A. Product Requirements -
 1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of greater than or equal to 50,000 hours as defined by IES LM-80 and TM-21.
 3. Each luminaire shall be designed to operate at an average operating temperature of 25°C.
 4. The operating temperature range shall be 10°C to +25°C.
 5. Some parameters and tests (such as IESNA standard LM-80-08) shall be conducted at different ambient temperatures.
 6. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.
 7. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

8. Each luminaire shall be listed with a nationally recognized testing laboratory (including but not limited to UL, CSA, ETL) under UL 1598 and UL 8750, or an equivalent standard from a recognized testing laboratory.

B. Technical Requirements –

1. Electrical:

- a. Power Efficacy: Minimum power efficacy allowed for the luminaire shall be 85 Lumens per Watt at an input voltage of 277 VAC.
- b. Operation Voltage
 - 1) The luminaire shall operate from a 60 HZ \pm 3 HZ AC line over a voltage ranging from 110 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 - 2) The standard operating voltages are 120 VAC, 277 VAC.
- c. Power Factor: The luminaire shall have a power factor of 0.90 or greater at all standard operating voltages
- d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.
- e. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
 - 1) The surge protection which may reside within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 1991 for Location Category A Low. Where failure does not mean a momentary loss of light during the transient event.
- f. Operational Performance: The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified above.
- g. RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
- h. Dimming: The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output, unless scheduled otherwise. Dimming shall be controlled by a 0-10V signal.

C. Photometric Requirements -

1. Light Output

- a. The manufacture shall publish initial lumen output of the luminaire in the 0-90 degree zone - as measured by IESNA Standard LM-79-08.
- b. Projected L70 life shall be at least 50,000 hrs based on IESNA TM-21 calculations performed using IESNA LM-80 test data.
- c. The measurements shall be calibrated to standard photopic calibrations.

2. Light Color/Quality.

- a. Corrected Color temperature (CCT) range between 3,500K and 4,100K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
- b. The color rendition index (CRI) shall be 80 or greater.

D. Thermal Management -

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the rated minimum operational life.
 - a. The LED manufacturer's maximum junction temperature for the rated minimum operational life shall not be exceeded at the average operating ambient.
 - b. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
 - c. The luminaire shall have an UL IC rating, if recessed into an insulated ceiling.
2. The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design.
 - a. The use of fans or other mechanical devices shall not be allowed.

E. Physical and Mechanical Requirements -

1. The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply for the luminaire shall be integral to the unit.
2. The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
3. The optical assembly of the luminaire shall assure individual LED image are not visible to the occupant.
4. The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements
5. The circuit board and power supply shall be contained inside the luminaire.
6. Electrical connections between normal power, driver and LED boards must be modular. All electrical components must be easily accessible after installation from the room side and all electrical components must to be able to be replaced without removing the fixture from the ceiling.
7. Housings shall be fabricated from post or pre-painted aluminum or cold rolled steel.
 - a. Each refractor or lens shall be made from UV inhibited high impact plastic (such as acrylic or polycarbonate) or heat and impact resistant glass,
 - b. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. The lenses (lens) of the luminaire are excluded from this requirement.

- F. Acceptable Manufacturers – Lithonia, Williams, Cooper, Visa, as scheduled, or approved equivalent.

2.3 ACCESSORIES:

- A. Manufacturers' standard mounting ring, trim flanges, hanger bars, spacers, supports, plaster frames of non-ferrous material or cadmium plated steel. Do not use painted steel plaster frames.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect Architectural drawings and specifications.
- B. Inspect Architectural reflected ceiling plans.
- C. Inspect installed ceiling components and construction for defects affecting the quality and execution of work.

3.2 PREPARATION:

- A. Utilize Architectural drawings and specifications to determine ceiling material to be installed.
- B. Verify ceiling material and alignment.
- C. Layout exact locations of fixtures in accordance with reflected ceiling plans, fixtures' and switches' outlet boxes and supports.
- D. Provide outlet boxes and conduit.
- E. Provide fixture trim and hardware appropriate for architecturally selected ceiling materials.
- F. Provide appropriate hardware to support outlet boxes from structure. Support light fixtures directly from building structure in accordance with Uniform Building Code Standard 25- 2.

3.3 INSTALLATION:

- A. Provide lighting fixtures, lamps, switches, and control systems, and wiring.
- B. If designation omitted on drawings, provide same type fixtures employed in rooms of similar usage.
- C. Provide spacers for fixtures mounted on low density ceiling material.
- D. Provide plaster frames for recessed fixtures in plaster ceilings.
- E. Install fixtures in and on acoustical tile ceilings in alignment with tile joints.
- F. Install fixtures in fiber decking and form board so outlet boxes and openings will not be sight exposed.

- G. Prepare fixtures and trim required to be painted. Refer to other Section.
- H. Note: Outlet boxes locations on drawings are diagrammatic only. Position outlet boxes to coincide with suspension hangers and knockouts.
- I. Install in accordance with manufacturer's instructions, submittal data, and details on the drawings.

3.4 ADJUSTMENT AND CLEANING:

- A. Adjustment: Adjust lamp positions for desired effects. Align fixtures with building walls and tile joints.
- B. Cleaning: Remove dirt, grease, and foreign materials from interior and exposed surfaces of all fixtures.

3.5 LIGHTING FIXTURE SCHEDULE: Refer to drawings for fixture schedule.

END OF SECTION 26 50 00

SECTION 26 01 50 – ICE AND SNOW MELTING FOR PAVEMENT**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Provide labor and equipment, materials and transportation to receive, install and put into operation complete, U.L listed and CSA certified snow melting system complete with heating cable, termination components, junction boxes and controls.
- B. Provide accessories required for the equipment to function properly and safely for the service intended.
- C. At the end of the one year warranty period, test the system for proper operation as described in Part 3 of this Specification Section. Any malfunctions shall be repaired at no cost to the Owner.

1.2 SUBMITTAL DATA:

- A. Submit complete printed catalog and descriptive data for each system component. Include:
 - 1. Manufacturer's product data sheets.
 - 2. Manufacturer's installation instructions.
- B. See section 26 01 00.

1.3 PERFORMANCE REQUIREMENTS:

- A. Snow Melting Installations: Nominal watts/square foot: Pedestrian Area 55 W/SqFt., Vehicle Area 45 W/SqFt.

1.4 REFERENCES:

- A. Underwriter's Laboratories (UL) – Directory of UL Listed Products
- B. Canadian Standards Association (CSA)
- C. National Electric Code (NEC): – Article 426 Fixed Outdoor Electric Deicing and Snow-Melting Equipment

1.5 PROJECT RECORD DOCUMENTS:

- A. Accurately record locations of heating cable, temperature and moisture sensors, thermostats and branch circuit connections.

1.6 COORDINATION:

- A. Coordinate installation of heating cable with Electrical Contractor, Concrete, Asphalt or Paving Contractor, and General Contractor.
- B. Coordinate installation of heating cable with installation of concrete framework and concrete placement.

1.7 QUALITY ASSURANCE:

- A. Manufacturer Qualifications:
 - 1. Minimum 25 years experience in design, engineering, manufacture and support of specified system and components
- B. Product Requirements
 - 1. All snow melting equipment furnished under this section shall be supplied by a single manufacturer.
 - 2. UL Listed and CSA Certified MI snow melting cables.
 - 3. Snow Melting Mats shall be identified as being suitable for the chemical, thermal, and physical environment, and installed per manufacturers drawings and instructions.
 - 4. Automatic snow melting control with continuous monitoring of ambient temperature, slab temperature, and slab moisture.
 - 5. Self Regulating cable is not acceptable for this application.
 - 6. MI snow melting cable shall be factory assembled, immersed in water for a minimum of 12 hours, and then tested for insulation resistance, high potential breakdown, and continuity before leaving the factory.

PART 2 - PRODUCTS**2.1 HEATING CABLE (where scheduled on drawings)**

- A. Mineral Insulated (MI) Heating Cable:
 - 1. UL Listed and CSA Certified Mineral Insulated (MI), seamless sheathed, series resistance heating cable.
 - 2. MI heating cable construction shall consist of MI copper sheath or MI stainless steel sheath, terminated in factory splice to stranded wire connection leads.
 - 3. MI copper sheath heating cable construction shall consist of MI copper sheath and have a high density polyethylene jacketing (HDPE) to provide extra corrosion and mechanical protection.
 - 4. Connection leads shall be of sufficient length to reach junction boxes or power panel as shown on detailed drawings. Connection leads shall be of stranded wire. Only connection leads in conduit shall exit from heated zone.
 - 5. Insulator shall be Magnesium Oxide only, a Fiberglass insulator is not permitted.
 - 6. No combustible materials between heating conductor wire and ground sheath.
 - 7. Cross section of heated portion of cable not to exceed 0.4 of an inch.
 - 8. Tie cable to rebar or reinforcing mesh.
 - 9. Cable rating shall of the voltage scheduled.

2.2 HEATING MATS (where scheduled on drawings)

- A. Snow Melting Mats:
1. Snow Melting Mat with alloy conductor wrapped with 4 mil Kapton® tape.
 2. Conductor to be encased with .034" thick, off white silicone rubber rated at 302°F.
 3. Aluminum braid shall provide ground path and mechanical strength.
 4. Watt density shall be approximately 50 watts per Square Foot.
 5. Cable output shall be up to 12 Watts per Linear Foot.
 6. Cable shall be attached to orange high-density polyethylene mesh.
 7. Mat rating shall be of the voltage scheduled.

2.3 CONTROLS

- A. DTC-24S, Automatic Control System:
1. Controller shall have:
 - a. 3-button key pad with single level menu.
 - b. LED Digital Display with manual temperature adjustment.
 2. System shall have a minimum of:
 - a. One 5" Diameter MP Sensor to sense moisture and slab temperature.
 - b. RID remote indicator and activation timer.
 3. System Activation:
 - a. When slab/ambient temperature is less than the setpoint temperature and snow or moisture is present on the MP sensor.
 4. System Deactivation:
 - a. System will remain active for the pre-set time duration after the sensor has dried or temperature rises about the setpoint.
- B. Power Control Panel with G.F.P.E:
1. Controller shall have:
 - a. NEMA 1 rated panel enclosure with one GFPE per circuit and one green "working" LED and one red "trip" LED per circuit.
 - b. One red "System On" LED, one green "Control Power On" LED, and one Amber "Trip Indicator" LED on panel door.
 - c. Interior G.F.P.E. Test button and include Dry alarm contacts.

2.4 ACCESSORIES

- A. Brass Embedded Heating System Marker: Fixed outdoor electric deicing marker (4" by 5" in size) shall be installed flush with surface.
1. NEC Article 426 Section 426-13, Identification, states that embedded snow-melting equipment must be evident by the posting of appropriate caution signs or markings.
- B. Acceptable Manufacturer – Delta-Therm, Pentair Thermal Management.

PART 3 - EXECUTION**3.1 SNOW MELTING CABLE INSTALLATION:**

- A. Install in accordance with manufacturer's instructions.
- B. The heating cable shall be installed only in concrete pavement that has been designed for long term structural integrity. The pavement shall be reinforced with rebar or wire mesh and the reinforcing supported such that the location of the reinforcing and the attached heating cable is not disturbed during the concrete placement. The rebar shall be placed at the heating-cable depth whenever possible.
- C. Complete installation shall conform to appropriate codes and shall also be in accordance with manufacturer's specification.
- D. Heating cable repairs and splices shall be made using a splice kit provided by the manufacturer and specifically approved for the purpose. They shall pass the Megger test after installation.
- E. Do not energize the system until concrete has thoroughly cured.
- F. MI heating cable shall not leave heated area or cross expansion or control joints.
- G. Pull stranded connector leads through conduit from condulets to junction boxes.
- H. Embedded MI condulet bodies in concrete to be filled fill with water repellent powder.
- I. Tie cable to rebar or reinforcing mesh.
- J. Position cables 2" to 3" inches below finished surface but not less than 1.5". Install cable in accordance with detailed layout drawings.
- K. Cable Spacing in Concrete: 5" to 8" inches on center per drawings.
- L. Do not pinch or make sharp bends in cable.
- M. Provide equipment ground fault protection for each heating cable circuit in accordance with the requirements of the National Electrical Code.
- N. Slab sensor(s) shall be placed between heating elements.

3.2 FIELD QUALITY CONTROL:

- A. Test continuity of heating cable.
- B. Test total resistance (TR) using an ohmmeter. The ohmmeter reading should be within 10% of the calculated Total Resistance.
- C. Perform Insulation resistance (IR) or "Megger" test on each heating cable before, during and after installation. Insulation resistance should be greater than 10 megohms.

- D. Measure voltage and current at each unit after concrete has set-up.
- E. Enter the total resistance and insulation resistance readings on the warranty card.
- F. Annually check system for loose or damaged cable.

3.3 ADJUSTING AND CLEANING:

- A. Keep automatic control system's slab sensor(s) clean of dirt and debris.

3.4 PROTECTION:

- A. Protect installed products until completion of project.

END OF SECTION 26 01 50

SECTION 26 16 00 - POWER DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide distribution panelboards, branch circuit panelboards, motor control centers, transformers and power factor correction equipment, as scheduled and specified for the electrical distribution system.

1.2 QUALITY ASSURANCE:

- A. Source Quality Control: Tests to meet applicable standards of the following:
 - 1. Underwriters' Laboratories.
 - 2. National Electrical Manufacturer's Association.
 - 3. National Electrical Code.
 - 4. American National Standards Institute.

1.3 SUBMITTALS:

- A. Submit shop drawings in accordance with other Sections. Include layouts showing cabinet dimensions, conduit entrances, electrical ratings, bussing connections, single line diagrams, device locations and ratings, and cable termination provisions.
- B. Certificates:
 - 1. Labels of Underwriters' Laboratories affixed to each item of material.
 - 2. Label of Underwriters' Laboratories approval for service entrance use, where applicable, affixed to material.
- C. See section 26 01 00.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION EQUIPMENT:

- A. Circuit Breaker Distribution Panelboard:
 - 1. Equivalent to Square D I-Line, all bussing - copper.
 - 2. 3 phase, 4 wire, solid neutral design with sequence bussing and full capacity neutral unless scheduled otherwise.
 - 3. Provide scheduled bolt-on panelboard circuit breakers, 22,000 Amp., R.M.S. minimum interrupting rating, or as scheduled on drawings.

4. Provide cabinets.
5. Provide feed thru lugs where extension of primary feeders is required.
6. Provide ground bus unless noted otherwise.
7. Provide isolated ground bus where scheduled.

B. Branch Circuit Panelboards:

1. Equivalent to Square D Type NQ and NF, all bussing - copper.
2. Single phase, 3 wire, and 3 phase, 4 wire, solid neutral design with sequence bussing and full capacity neutral.
3. Provide scheduled circuit breakers, minimum 10,000 A.I.C. for 208 volt and 14,000 for 480 volt.
4. Provide feed thru lugs where extension of primary feeders is required.
5. Provide cabinets of NEMA type appropriate for application.
6. Provide isolated ground bus where scheduled.

C. Circuit Breakers:

1. Resettable, quick-make, quick-break, thermal magnetic type, ambient compensated, trip free with separate trip position from on and off positions.
2. Multiple pole breakers with common trip and one operating handle. Do not provide handle ties.
3. 15 and 20 ampere, single pole circuit breakers shall be U.L. listed as switching duty rated.
4. Wire with sequence phasing.
5. Provide circuit breakers of appropriate capacity for all unscheduled circuits.
6. For panelboards rated 600 amperes or greater, provide bolt- on type circuit breakers.
7. Provide U.L listed HACR circuit breakers for compressorized equipment loads where the circuit breaker serves as the final overcurrent protection.
8. Where indicated on the panel schedule, provide panel mounted power supply to provide 24 volts DC switching power for remote controlled circuit breakers.
9. Breakers indicated to be "Remote Controlled":
 - a. Circuit breakers shall be UL Listed and rated 120/ 240Vac (1- and 2-pole) and 240Vac (3-pole) with continuous current ratings as shown on the plans.
 - b. Circuit breakers shall have an overcenter, trip-free, toggle type, quick-make/quick-break mechanical action and positive handle indication. Handle shall have on, off, and tripped positions. In addition, trip indication shall include a trip indicator on the face of the breaker case.
 - c. Multi-pole breakers shall have internal crossbars for common trip operation.
 - d. Circuit breaker contacts shall be open when breaker is in the OFF or "tripped" position regardless of remote signal.
 - e. Interrupting capacity shall be 10,000 rms symmetrical amperes.
 - f. 15A and 20A breakers shall be SWD rated.
 - g. Multipole circuit breakers rated 15-60A shall be UL Listed for HACR applications.
 - h. All circuit breakers shall have contacts suitable for use on HID lighting systems.
 - i. Circuit breakers shall be marked "Remote Controlled" in such a way that the marking is visible with the trim installed.
 - j. Circuit breakers shall have terminals suitable for use with Al/Cu 75°C wire.

- k. Circuit breakers shall be capable of operating for 30,000 operations at rated voltage and current with an 80% lagging power factor.
- l. Remote-control shall be accomplished via a 24Vdc high speed motor with clearing switch that clears the motor circuit upon circuit breaker contact opening or closing.
- m. Motor shall operate no more than 50 milliseconds at rated voltage (24Vdc) $\pm 10\%$ and draw no more than 2A instantaneous. Maintaining the control signal shall have no adverse effect on the breaker.

D. Enclosed Circuit Breakers:

1. Equivalent to Square D LHL, MHL and PJJ.
2. 3 phase, 4 wire, solid neutral design with sequence bussing, copper and full capacity neutral unless scheduled otherwise.
3. 65,000 Amp., R.M.S. minimum interrupting rating, or as scheduled on drawings.
4. Provide dual rated lugs for supply and load conductors.
5. Provide cabinets of NEMA type appropriate for application. Outdoor enclosures shall be equipped with factory installed means to padlock door.
6. Weather proof hubs and threaded conduit connections shall be used for outdoor circuitry.
7. Provide ground bus unless noted otherwise.

E. Dry Type Transformers:

1. Two windings of the size and electrical characteristics as scheduled.
2. Guaranteed sound levels shall not exceed ANSI standard decibel levels. Transformers shall be rated at full load in a 40°C ambient with 30°C ultimate hot spot temperature rise allowance, with Class F insulation having a UL 185°C rating limiting system temperature to 115°C on 25 kVA and smaller units, and Class H insulation having a UL 220°C rating limiting system temperature to 150°C on 30 kVA and larger units.
3. The maximum temperature rise of the top of the enclosure shall not exceed 35°C over a 40°C ambient.
4. Transformers rated at 30 kVA and above shall have core and coil assembly completely isolated from enclosure with neoprene rubber pads, and six primary voltage taps rated (4) 2-1/2 percent normal and (2) 2-1/2 percent above normal. Transformers rated at 25 KVA and below shall have four primary voltage taps rated (2) 2-1/2 percent below normal and (2) 2-1/2 percent above normal.
5. Make necessary tap adjustments on transformers to insure that the secondary voltages at the transformer terminals will be as close as possible to 120 volts phase-to-neutral, and 208 volts phase-to-phase, when the building is in normal operation.
6. Transformers shall have heat barriered termination compartment arranged for feeder terminations for side or bottom entrance of flexible metallic raceways.
7. Transformers shall have a bonding jumper installed between the secondary neutral terminal and the metal case and shall include a ground terminal of proper size to receive ground conductor.

F. Acceptable Manufacturers – Eaton, General Electric, Siemens, Square D.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Carefully measure and lay out exact locations of equipment in conference with the Construction Manager.
- B. Assure that equipment may be installed without adversely affecting the integrity and appearance of the building structure and with the clearances required by the National Electrical Code.

3.2 INSTALLATION:

- A. Provide panelboards of the types and ratings scheduled where indicated.
- B. Provide flush and surface mounted types where indicated and scheduled.
 1. Provide multi-section cabinets as required and scheduled; one-piece covers and doors, main and sub-feed lugs as required.
 2. Provide hinged doors with flush tumbler lock and catch, all locks keyed alike.
 3. Provide 3 keys for each panelboard.
- C. Provide supports to the building structure, independent of raceways.
- D. Install tops of panelboard cabinets at 6 feet, 6 inches, above finished floor.
- E. Install panelboards in cabinets, centered in door openings.
- F. Provide Identification:
 1. For Panelboards - Engraved, lamacoid plastic name plate, giving equipment designation.
 2. For Distribution and Branch Circuit Panelboards: - Neatly typewritten circuit directory in cardholder inside panelboard door.
 - a. For Branch Circuit Panelboards: Identify rooms served using room numbers corresponding to those finally established at the project.
 - b. For Distribution Panelboards: Identify the equipment served and give circuit designation.
 - c. For motor starters identify equipment designation as scheduled on the drawings, voltage and phase of service, and the source of power.
- G. Provide Vibration Isolation for Suspended Transformers:
 1. Provide spring hangers, equivalent to Mason Type PC30, 1" deflection, consisting of a rectangular steel box, coil spring, spring cups, neoprene impregnated fabric washer, and steel washer, with an elastomeric element at the top of the box for acoustic isolation. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall be designed for approximately 1/4-inch deflection and loaded so that deflection does not exceed 15 percent of the free height of the element.
 2. Install the isolators with the isolator hanger box as close as possible to the structure.
 3. Suspend the isolators from the building structure, never from slab diaphragms between beams.

3.3 FIELD QUALITY CONTROL:

- A. Perform manufacturer's recommended field tests prior to energization.
- B. Provide copies of test results to the Owner's representative.

END OF SECTION 26 16 00

SECTION 26 17 00 - MOTOR AND CIRCUIT DISCONNECTS**PART 1 - GENERAL****1.1 SCOPE**

- A. Provide disconnect switches for branch circuit, motor circuits, and all items of equipment in conformance with the National Electric Code.

1.2 QUALITY ASSURANCE

- A. Source Quality Control: Tests to meet applicable Underwriters' Laboratories, Inc. Standards, the National Electrical Manufacturer's Association and the National Electrical Code.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with other Sections. Include enclosure dimensions, type, electrical ratings, fuse provision, installation instructions, and name plate nomenclature.
- B. Certificates:
 - 1. Labels of Underwriters' Laboratories, Inc. affixed to each item of materials.
- C. See Section 26 01 00.

1.4 JOB CONDITIONS:

- A. Provide switch sizes as required by the National Electrical Code based on the equipment actually furnished under other Divisions or provided by the Owner.

PART 2 - PRODUCTS**2.1 EQUIPMENT**

- A. For single phase motors under 1/2 horsepower: Equivalent to Square D Class 2510 Fractional Horsepower single phase two pole manual starter with toggle type switch, locking attachment, neon pilot light, thermal overload elements sized per motor name plate rating and NEMA 1 enclosure indoors, NEMA 4 enclosure exterior, in damp or wet locations and in crawl spaces, flush and surface as specified for outlet boxes.

- B. For single and three phase motors, 120, 230, 480 volts, 1/2 to 3 horsepower, requiring manual starters: Equivalent to Square D Class 2510 Integral Horsepower manual starter with toggle type switch, low voltage protection, pilot light, thermal overload elements sized per motor name plate rating with number of poles required for specific application and NEMA 1 enclosure indoors, NEMA 3R enclosure exterior, in damp or wet locations and in crawl spaces, flush and surface as specified for outlet boxes.
- C. For Other 250 Volt Equipment: Equivalent to Square D Class 3130 NEMA Type GD Safety Switches, fusible and non-fusible as required by NEC with cover interlocks, with NEMA cabinet required for application, with threaded hubs.
- D. Acceptable Manufacturers - Cutler Hammer, General Electric, Siemens ITE, Square D.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect building structure to which disconnects are to be secured for defects which affect the execution and quality of work.
- B. Do not start work until defects are corrected.

3.2 PREPARATION

- A. Carefully measure and lay out exact locations maintaining working clearances required by the National Electrical Code.

3.3 INSTALLATION

- A. Provide disconnects where indicated and where required by the National Electrical Code.
- B. Install within sight of equipment served.
- C. Provide final connection to equipment served.
- D. Provide name plate secured to cabinet with designation of equipment served, operating voltage, and circuit designation.

3.4 EQUIPMENT CONNECTIONS

- A. Provide wiring for the connection of motors and control equipment and control wiring as indicated on the Electrical Drawings.

1. Equipment installed under Other Sections - wiring shall be extended to the equipment, and proper connections made thereto.
2. Flexible connections of short lengths - shall be provided for equipment subject to vibration or movement and for motorized and compressor equipment. Liquid-tight conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.
 - a. Length of flexible connections for motors shall be at least 11-inches plus 1/4-inch per horsepower up to 100 hp, and need not be longer than 36-inches unless otherwise indicated.
 - b. Length of flexible connections for transformers shall be at least 11-inches plus 1/4-inch per KVA up to 100 KVA, and need not be longer than 36-inches unless otherwise indicated.
3. Power connections to any vibration isolated equipment shall be made with a length of flexible conduit having a 90 degree bend in it between the junction box on the equipment and any non-flexible conduit.
4. Owner furnished equipment - wiring shall be extended to the equipment, and proper connections made thereto.

END OF SECTION 26 17 00

SECTION 26 41 30 - STANDBY GENERATOR SYSTEMS – NATURAL GAS ENGINE**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK:**

- A. Provide a new natural gas engine-driven standby generator system to supply the emergency power system indicated on the Drawings and schedules.
- B. Provide manufacturer recommended vibration isolation for engine-generators, including pads, springs, rails, bases, hangers, and connectors.
- C. Provide flexible gas piping adapter/connector for final connection of rigid gas piping.
- D. Provide one (1) unit mounted main circuit breakers to prevent overloading of the generator and power supply conductors.
- E. Provide a complete and fully operational standby power generation system including all engine fueling, heat rejection, starting and operation controls and safeties, voltage regulation, output breaker, battery charging, coolant jacket heating, etc.
- F. Provide a two (2) 20 ampere, 120 volt branch circuits to the generator battery charging system and the engine block heater from a branch circuit panel indicated on the drawings.
- G. Provide supplemental grounding of the generator set with a #6 copper grounding conductor routed to the building grounding electrode system.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of engine-driven standby generator systems, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 3 years of successful installation work similar to that required for Project.
- C. NEC Compliance: Comply with applicable standby generator requirements of NEC including, but not limited to, Article 700, emergency power systems.
- D. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", and NFPA 110 requirements for Level 1 emergency power supply system.
- E. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches":. Provide standby generator system components, including automatic transfer switches, which are UL listed and labeled.

- F. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators".
- G. IEEE Compliance: Comply with applicable portions of IEEE Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to standby power.

1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on engine-driven electric generator systems and components. Include manufacturer's standard product warranty (for not less than one-year period) for replacement of materials and equipment used in standby engine-driven generator system.
- B. Shop Drawings: Submit drawings of engine-driven generator units and accessories including, but not limited to, automatic transfer switch, fuel line piping, remote start-stop stations, and instruments, showing accurately scaled generator set layout and its connections to remote equipment.
- C. See Section 26 01 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide standby generator systems of one of the following (for each type of electric generator unit):
 - 1. Caterpillar Tractor Co.
 - 2. Cummins Engine Co.
 - 3. Kohler Power Systems
 - 4. MTU Onsite Energy Corporation

2.2 ENGINE-GENERATOR UNITS:

- A. Natural Gas Engine-Driven Generator: Provide an alternating-current standby engine-driven generator unit as scheduled, rated at 75 percent PF for continuous standby operation, 60 Hz; equip with natural gas, water cooled engine with unit mounted radiator; connected directly to 4-pole revolving-field type generator.
- B. Equip generator set with associated control equipment to automatically start engine, transfer load to standby power upon failure of normal power source, transfer load back to normal power source upon its restoration, and stop engine. Cushion mount engine-generator on heavy steel base with vibration isolators to reduce possibility of torsional vibration. Generator set must be capable of starting and accelerating to nominal operating RPM and voltage ready to accept load transfer within 10 seconds.

- C. Equip generator set with a permanent magnet generator (PMG) power excitor and voltage regulator to maintain voltage within 2% of rated value. Provide unit capable a voltage recovery, within regulated range, of 8 seconds following a sudden load increase from 0 percent to 100 percent of rated load. On application of any load up to rated load, the instantaneous voltage dip shall not exceed 15% and shall recover to + or - 5% of rated voltage within 1 second.
- D. Equip engine with low-oil pressure, high-water temperature, and automatic overspeed safety shutdown devices.
- E. Construct unit in compliance with applicable standards; and with additional construction features as indicated:
 - 1. Rust-resistant weather protective housing made of painted heavy gauge reinforced steel, with exhaust muffler, and air intake and discharge louvers or screens to permit proper cooling, and access to controller and service points. Access panels shall be lockable. The exhaust muffler shall be mounted inside the enclosure. The enclosure shall be sound attenuated with a maximum average sound level measured at 8 locations 23ft from the enclosure not exceeding 75dBA. A sound test report will be required with the submittals. Sound data shall be measured at full load.
 - 2. Provide engine with 24-volt starting system including batteries, starting motor, and charging unit with automatic charging rate regulator.
 - 3. Instrument Control Panel: Provide standby generator unit with engine oil-pressure and water-temperature indicators, battery charge-rate ammeter, START and STOP button for manual operation of unit, reset circuit breaker, (static) voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with OFF position, and with running time and frequency meters.

2.3 ENGINE-GENERATOR UNIT ACCESSORIES:

- A. Provide visual and audible alarm to warn of emergency operating conditions affecting auxiliary power source.
- B. Provide thermostatically controlled block heater to maintain engine in start capable condition to -10 degrees Fahrenheit ambient temperature.
- C. Provide exhaust pipe and silencer, coated to be temperature and rust resistant, as recommended by the engine manufacturer. Provide exhaust pipe rain cap.
- D. Provide unit mounted resettable line sensing main circuit breakers with inverse time versus current response. Circuit breakers shall not automatically reset preventing restoration of voltage if maintenance is being performed. This breaker shall protect the generator from damage due to its own high current capability and shall not trip within 10 seconds to allow selective tripping of downstream fuses or circuit breakers under a fault condition.
- E. Provide automatic transfer switches of types capacities indicated. Transfer switch controls shall be fully compatible and fully functional with the engine-generator

controls. Provide complete controls installation for interface of transfer switch control of engine-generator start/stop and other functions.

1. See Section 26 41 60.

- F. Provide wall-mounted automatic battery charger in NEMA 1 enclosure. Battery charger shall be current-limiting, automatic float-charging type complying with UL 1236, with equalizing charging rate of 10 amperes, with automatic temperature compensation, automatic voltage regulation, ammeter and voltmeter and power ON pilot light flush-mounted in door, reverse polarity protection, AC input and DC output fuses, and alarms for low battery voltage, high battery voltage and battery charger malfunction. Battery charger shall be installed inside the generator enclosure, inside the electrical room, or inside the transfer switch.
- G. Provide remote annunciator panel with visual and audible alarm to warn of emergency operating conditions affecting auxiliary power source. Provide remote alarm contacts to signal building controls that a generators set alarm has been initiated.
- H. Contractor to provide and install gas pressure regulator and piping capable of supplying the scheduled fuel consumption.

2.4 ENGINE-GENERATOR SCHEDULE: See drawings.

PART 3 - EXECUTION

3.1 INSTALLATION OF ENGINE-GENERATOR SYSTEMS:

- A. Install standby engine-generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator sets fulfill requirements. Provide all circuitry required between engine-generator unit and battery charger and automatic transfer switch to provide a complete system. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories.
- B. Coordinate with other work as necessary to interface installation of standby generator system work with other work.
- C. Align shafts of engine and generator within tolerances recommended by equipment manufacturer.

3.2 GROUNDING:

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components as indicated.

- B. Provide supplemental grounding of the unit chassis with a #6 AWG grounding conductor to a U.L. listed 3/4" x 10' copper clad ground rod adjacent to the building.

3.3 TESTING:

- A. Upon completion of installation of engine-generator system and after building circuitry has been energized with normal power source, test engine-generator to demonstrate standby capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.
- B. Perform all tests recommended by manufacturer and submit test logs demonstrating successful completion of all tests.

3.4 TRAINING:

- A. Engage a factory-authorized representative to train Owner's personnel to adjust, operate and maintain this system.
 - 1. Train Owner's personnel in procedures and schedules for starting, stopping, testing, troubleshooting, servicing and maintaining system.
 - 2. Review data in maintenance manuals.
- B. Schedule training with Owner, with at least 14 days' advance notice.

END OF SECTION 26 41 30

SECTION 26 41 60 - AUTOMATIC TRANSFER SWITCHES**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install the transfer switches as herein specified and indicated on the associated electrical drawings.
- B. Provide automatic transfer switch configured units for the indicated applications.
- C. Furnish for this work automatic transfer switches rated 600 V and less. All electrical ratings and performance shall be suitable for the specific application indicated herein and on the project drawings.

1.2 QUALITY ASSURANCE

- A. The transfer switches referenced herein shall be listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008. Transfer switches shall be designed and manufactured according to latest revision of the applicable standards of the following:
 - 1. Underwriters' Laboratories including UL 1008, UL 508.
 - 2. National Electrical Manufacturer's Association including NEMA ICS 10-1993.
 - 3. National Fire Protection Association including NFPA 70, NFPA 99 and NFPA 110.
 - 4. American National Standards Institute.

1.3 SUBMITTALS

- A. Submit shop drawings which shall indicate:
- B. Enclosure with overall dimensions and elevations showing minimum clearances, conduit and conductor entry provisions and requirements, gutter space, electrical ratings, bussing connections for phase, neutral, and ground; one-line diagrams, and cable termination provisions.
- C. Include ratings and installed features and devices, and material lists for each switch specified.
- D. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Indicate both power and all control wiring for supplied features.
- E. Certificates:
 - 1. Labels of Underwriters' Laboratories affixed to each item of material.
 - 2. Product Certificates: Certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.

- F. Operation and Maintenance Manual:
1. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.
 2. Maintenance Data: Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.
- G. See Section 26 01 00.

1.4 QUALIFICATIONS

- A. To be considered for approval, a manufacturer shall have specialized in the manufacturing and assembly of automatic transfer switches for at least twenty (20) years.
- B. The Manufacturer must maintain a service center capable of providing emergency maintenance and repairs at Project site with an eight-hour maximum response time.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA recommended service conditions during and after installation of switchboards.

1.6 MAINTENANCE MATERIALS & WARRANTY

- A. Provide one (2) sets of installation and maintenance instructions with each transfer switch. One set of instructions are to be easily identified and affixed within the enclosure cabinet in a readily accessible location the other set shall be delivered to the Owner.
- B. The manufacturer shall warrant the material for a period of five (5) years from the start up and commissioning date. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Automatic Switch Company, Caterpillar, Cummins Power Generation, Kohler Power Systems, Zenith Controls, Inc.

2.2 AUTOMATIC TRANSFER SWITCH

- A. Ratings:

1. Integrated Short Circuit Current Rating: Switches shall have a minimum short circuit current rating in RMS symmetrical amperes at the system AC voltage. Transfer switches that have withstand ratings based on series ratings or specific type circuit breaker requirements are not acceptable.
2. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
3. All power switching contacts shall be fully rated including neutral contacts where used.
4. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by coordinated protective devices at installation location under the fault conditions indicated, based on testing according to UL 1008.
5. The automatic transfer switch unit shall be mounted in a metal enclosure as shown on the project drawings. The electrical construction shall utilize only copper bussing and conductors and be supplied as a pre-tested assembly.

B. Electrical Characteristics:

1. The power terminal arrangement and field wiring space shall be suitable for top, side, or bottom entrance of feeder conductors as indicated.
2. Electrical operation shall be accomplished by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
3. The switch shall be designed for continuous-duty repetitive transfer of full-rated current between active power sources. The switch action shall be double throw, mechanically held in both directions. Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
4. Automatic Transfer Switch Schedule:
 - a. See Drawings.

C. Transfer Switch Features and Operation:

1. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
2. Manual Switch Operation: Under load or unloaded, with door closed and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
3. Signal Contacts: Provide control relays with normally open/normally closed dry contacts rated 10 A at 240 VAC. Contacts shall indicate status and/or operation of the specified functions controlled by or interfaced with the automatic transfer unit. Contacts shall provide the following signal functions:
 - a. Standby source connected.
 - b. Utility source connected.
 - c. Pre-transfer signal with adjustable time delay.
4. Failure of the power source serving the load initiates automatic break-before-make transfer.
5. A synchronization sensing relay (in-phase monitor) shall be provided for transition operation between live sources.

6. Undervoltage sensing for each phase of normal source shall sense low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 90 to 95 percent of nominal, and dropout voltage is adjustable from 70 to 90 percent of pickup value. Initially set for pickup at 90 percent and dropout at 80 percent.
7. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to ten seconds, and initially set for three seconds.
8. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes; factory set for 5 minutes. Provides automatic defeat of delay on loss of voltage or sustained under-voltage of emergency source, provided normal supply has been restored.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated, normally closed rated 10 A at 32 VDC minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to thirty minutes; initially set for twenty minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

D. Annunciation and Control Components:

1. Repetitive accuracy of all control settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
2. Solid state devices shall have protection for resistance to damage by voltage transients. Protective components meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.
3. Operator controls and diagnostic indicators:
 - a. Test Switch: Simulates normal source failure.
 - b. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - c. Source-Available Indicating Lights: Supervise sources via transfer switch, normal and emergency source sensing circuits.
 - d. Switch Status: Normal or Test Mode.
 - e. Normal Power Supervision: Green light with permanent indication: "Normal Source Available."
 - f. Emergency Power Supervision: Red light with permanent indication: "Emergency Source Available."

- E. Enclosure: Provide Type 1 for indoor applications and Type 3R for outdoor applications.
 - 1. The enclosure shall be painted on all exterior surfaces.
 - 2. Shall be of deadfront construction.
 - 3. The frame shall be of formed UL gauge steel rigidly bolted or welded together to support all cover plates, bussing and component devices during shipment and installation.
- F. Identification: Provide 1"H X 4"W engraved laminated plastic nameplates for unit. Nameplates shall indicate unit ID and distribution branch served, (i.e. "ATS-1").
- G. Ground Bus: Sized per NFPA 70 and UL 891.
- H. Required accessibility shall be from the front of the enclosure only.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate all signal requirements for transfer switch to generator interface including minimum run time, delays, projected voltage sags, etc. Obtain written list of generator set operating parameters relevant to remote operation from generator set supplier.

3.2 INSPECTION

- A. Examine area to receive equipment to provide adequate clearance for transfer switch installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.
- B. Inspect and have any damaged components replaced or, with the approval of the Engineer, repaired to new condition.
- C. Store in a clean, dry space. Maintain factory protection and/or provide an additional cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.

3.4 INSTALLATION

- A. Install unit in accordance with manufacturer's written instructions, and NEC.
- B. Level and anchor switch unit to concrete housekeeping. Mount annunciator and control panel in supported cabinet, unless otherwise indicated.
- C. Provide wiring to remote components. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by manufacturer. Provide required raceways to accommodate required control wiring.
- D. Provide control circuitry for automatic starting of engine- generator set upon signal from the transfer switch automatic controls.
- E. Provide control circuitry to plant motor loads for appropriate start or lockout control of designated motorized equipment.
- F. Provide signal circuitry to plant logic controllers for the purpose of initiating appropriate operating mode as programmed for each controller.
- G. Ground equipment as indicated and as required by NFPA 70.

3.5 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- C. Perform all manufacturer's recommended field tests prior to energization. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing.
- D. Perform general testing with the Owners representative in attendance and log results. Submit dated, signed test log with O & M Manual.
 - 1. Test transfer-switch products by operating them in all modes. Record adjustable relay settings.
 - 2. Perform the following field quality-control testing under the supervision of the manufacturer's factory-authorized service representative in addition to tests recommended by the manufacturer:
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage; proper installation and connection; and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 - e. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

- f. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
- g. Verify time-delay settings.
- h. Verify pickup and dropout voltages by data readout or inspection of control settings.
- i. Test all functional modes and related automatic transfer-switch operations.
- j. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown sequence.
- k. Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- l. Assist in verifying grounding connections and locations and ratings of sensors.
- m. Coordinate tests with tests of generator plant and run them concurrently.
- n. Coordinate testing with Owner's schedule requirements. Schedule testing during "Off Peak" hours as required by Owner.
- o. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.

3.7 CLEANING

- A. Clean all scrap material, dirt, debris, etc. and touch up paint scratched or marred surfaces to match original finish.
- B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.8 TRAINING

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related. Review data in "Operation and Maintenance Data." Schedule sessions at Owner's convenience. Coordinate training with generator testing.
 1. Provide two two hour sessions for maintenance training. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
- B. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

3.9 DOCUMENTATION

- A. Provide to the Engineer, 3 copies each of all as-built final documentation including all test results, electronic device settings and final setpoints. Include operating instructions for setpoint adjustment and complete programming manual for all panel adjustable parameters.
- B. Include all shop drawings as-built drawings, operating and maintenance instructions and test results in the project Operation and Maintenance manuals.
- C. Provide block wiring diagrams for all field equipment interlocked with transfer switch controls. Identify transfer switch termination points and provide written description of operational sequence with specific identification of time delays.

END OF SECTION 26 41 60

SECTION 26 50 00 - LIGHTING**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Conditions of the Contract and General Requirements are hereby made a part of this section.
- B. Provide lighting fixtures, lamps, and accessories for interior and exterior illumination of the building.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Exceptions to manufacturers listed with each item shall be made in accordance with the General Requirements.
- B. Laboratory Testing: Photometric testing shall be by Independent Testing Laboratories, Inc., based on Illuminating Engineering Society published procedures, and shall include candlepower distribution tabulation and zonal cavity coefficient of utilization tabulation.
- C. Standards:
 - 1. All lighting fixtures shall meet Underwriters' Laboratories, Inc., applicable standards.
 - 2. Fixtures shall be provided possessing Underwriters' Laboratories location duty listings as required by the specific application.
 - a. Exposed Outdoors - Wet Location
 - b. Sheltered Outdoors - Damp location
- D. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.
- F. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.
- G. UL Compliance: Provide light fixtures that have been UL listed and labeled.

1.3 SUBMITTALS:

- A. Submit manufacturer's literature giving materials, finishes, dimensions, coefficients of utilization, and lamp types for each fixture which is the product of one of the listed acceptable manufacturers.

- B. Submit samples of fixtures upon specific request.
- C. See Section 26 01 00.

1.4 CERTIFICATES:

- A. Labels of Underwriters' Laboratories, Inc.; Certified Ballasts Manufacturers, and Electrical Testing Laboratories affixed to each item of material.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FIXTURE MANUFACTURERS:

- A. Listed in schedule and with materials.
- B. Substitutions: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. Copies sent via facsimile or e-mail will not be accepted. After review of the proposed substitute fixtures, an addendum may be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures of other manufacturers. The Architect/Engineer shall have the final authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item

2.2 LED LIGHT FIXTURES:

- A. Product Requirements -
 1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of greater than or equal to 50,000 hours as defined by IES LM-80 and TM-21.
 3. Each luminaire shall be designed to operate at an average operating temperature of 25°C.
 4. The operating temperature range shall be 10°C to +25°C.
 5. Some parameters and tests (such as IESNA standard LM-80-08) shall be conducted at different ambient temperatures.
 6. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.
 7. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

8. Each luminaire shall be listed with a nationally recognized testing laboratory (including but not limited to UL, CSA, ETL) under UL 1598 and UL 8750, or an equivalent standard from a recognized testing laboratory.

B. Technical Requirements –

1. Electrical:

- a. Power Efficacy: Minimum power efficacy allowed for the luminaire shall be 85 Lumens per Watt at an input voltage of 277 VAC.
- b. Operation Voltage
 - 1) The luminaire shall operate from a 60 HZ \pm 3 HZ AC line over a voltage ranging from 110 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 - 2) The standard operating voltages are 120 VAC, 277 VAC.
- c. Power Factor: The luminaire shall have a power factor of 0.90 or greater at all standard operating voltages
- d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.
- e. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
 - 1) The surge protection which may reside within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 1991 for Location Category A Low. Where failure does not mean a momentary loss of light during the transient event.
- f. Operational Performance: The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified above.
- g. RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
- h. Dimming: The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output, unless scheduled otherwise. Dimming shall be controlled by a 0-10V signal.

C. Photometric Requirements -

1. Light Output

- a. The manufacture shall publish initial lumen output of the luminaire in the 0-90 degree zone - as measured by IESNA Standard LM-79-08.
- b. Projected L70 life shall be at least 50,000 hrs based on IESNA TM-21 calculations performed using IESNA LM-80 test data.
- c. The measurements shall be calibrated to standard photopic calibrations.

2. Light Color/Quality.

- a. Corrected Color temperature (CCT) range between 3,500K and 4,100K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
- b. The color rendition index (CRI) shall be 80 or greater.

D. Thermal Management -

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the rated minimum operational life.
 - a. The LED manufacturer's maximum junction temperature for the rated minimum operational life shall not be exceeded at the average operating ambient.
 - b. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
 - c. The luminaire shall have an UL IC rating, if recessed into an insulated ceiling.
2. The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design.
 - a. The use of fans or other mechanical devices shall not be allowed.

E. Physical and Mechanical Requirements -

1. The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply for the luminaire shall be integral to the unit.
2. The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
3. The optical assembly of the luminaire shall assure individual LED image are not visible to the occupant.
4. The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements
5. The circuit board and power supply shall be contained inside the luminaire.
6. Electrical connections between normal power, driver and LED boards must be modular. All electrical components must be easily accessible after installation from the room side and all electrical components must to be able to be replaced without removing the fixture from the ceiling.
7. Housings shall be fabricated from post or pre-painted aluminum or cold rolled steel.
 - a. Each refractor or lens shall be made from UV inhibited high impact plastic (such as acrylic or polycarbonate) or heat and impact resistant glass,
 - b. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. The lenses (lens) of the luminaire are excluded from this requirement.

- F. Acceptable Manufacturers – Lithonia, Williams, Cooper, Visa, as scheduled, or approved equivalent.

2.3 ACCESSORIES:

- A. Manufacturers' standard mounting ring, trim flanges, hanger bars, spacers, supports, plaster frames of non-ferrous material or cadmium plated steel. Do not use painted steel plaster frames.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect Architectural drawings and specifications.
- B. Inspect Architectural reflected ceiling plans.
- C. Inspect installed ceiling components and construction for defects affecting the quality and execution of work.

3.2 PREPARATION:

- A. Utilize Architectural drawings and specifications to determine ceiling material to be installed.
- B. Verify ceiling material and alignment.
- C. Layout exact locations of fixtures in accordance with reflected ceiling plans, fixtures' and switches' outlet boxes and supports.
- D. Provide outlet boxes and conduit.
- E. Provide fixture trim and hardware appropriate for architecturally selected ceiling materials.
- F. Provide appropriate hardware to support outlet boxes from structure. Support light fixtures directly from building structure in accordance with Uniform Building Code Standard 25- 2.

3.3 INSTALLATION:

- A. Provide lighting fixtures, lamps, switches, and control systems, and wiring.
- B. If designation omitted on drawings, provide same type fixtures employed in rooms of similar usage.
- C. Provide spacers for fixtures mounted on low density ceiling material.
- D. Provide plaster frames for recessed fixtures in plaster ceilings.
- E. Install fixtures in and on acoustical tile ceilings in alignment with tile joints.
- F. Install fixtures in fiber decking and form board so outlet boxes and openings will not be sight exposed.

- G. Prepare fixtures and trim required to be painted. Refer to other Section.
- H. Note: Outlet boxes locations on drawings are diagrammatic only. Position outlet boxes to coincide with suspension hangers and knockouts.
- I. Install in accordance with manufacturer's instructions, submittal data, and details on the drawings.

3.4 ADJUSTMENT AND CLEANING:

- A. Adjustment: Adjust lamp positions for desired effects. Align fixtures with building walls and tile joints.
- B. Cleaning: Remove dirt, grease, and foreign materials from interior and exposed surfaces of all fixtures.

3.5 LIGHTING FIXTURE SCHEDULE: Refer to drawings for fixture schedule.

END OF SECTION 26 50 00

SECTION 26 51 00 – SITE LIGHTING**PART 1 - GENERAL****1.1 WORK INCLUDED:**

- A. Conditions of the Contract and General Requirements are hereby made a part of this section.
- B. Provide lighting fixtures, lamps, and accessories for exterior site illumination.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Exceptions to manufacturers listed with each item shall be made in accordance with the General Requirements.
- B. Laboratory Testing: Photometric testing shall be by Independent Testing Laboratories, Inc., based on Illuminating Engineering Society published procedures, and shall include candlepower distribution tabulation and zonal cavity coefficient of utilization tabulation.
- C. Pole Lighting performance shall meet the criteria established for the design of this project. The supplier shall provide calculated performance information in this work. The manufacturer shall supply photometric data for the supplied fixture in a standard IES format so that the calculations for this project may be independently verified.
- D. Standards:
 - 1. All lighting fixtures shall meet Underwriters' Laboratories, Inc., applicable standards.
 - 2. Fixtures shall be provided possessing Underwriters' Laboratories location duty listings as required by the specific application.
 - a. Exposed Outdoors - Wet Location
 - b. Sheltered Outdoors - Damp location
- E. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.
- F. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.
- G. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to exterior lighting fixtures.
- H. UL Compliance: Provide light fixtures that have been UL listed and labeled.

1.3 SUBMITTALS:

- A. Submit manufacturer's literature giving materials, finishes, dimensions, coefficients of utilization, and light source types for each fixture which is the product of one of the listed acceptable manufacturers. Include complete shop drawings of the fixture.
- B. Submit samples of fixtures upon specific request.
- C. See Section 26 01 00.
- D. Submit shop drawings for each ground and pole mounted site lighting assembly to include fixture and driver arrangement, maximum EPA per pole, total electrical loads and pole construction details, pole fixture lighting layout showing recommended pole locations, fixture types, aiming points and mounting heights.
 1. Submit IES format photometric data on standard digital data media for the submitted fixtures.
- E. Manufacturer shall submit for approval a computer calculation derived lighting layout showing point by point footcandle levels of the parking and sidewalk surfaces, maximum to minimum ratio and total energy consumption in KW per hour required for proposed layout. Point by point lighting level calculations shall identify maintained horizontal footcandle levels for comparison to the design.
 1. For LED fixtures, calculations to determine the maintained lighting levels shall be based on the following:
 - a. A 0.9 light loss factor.
 - b. Absolute fixture lumens.
 - c. Minimum illuminance for the paved parking and sidewalk areas of 1.0 footcandle.
 2. Submit IES format photometric data on standard digital data media for the submitted fixtures.

1.4 CERTIFICATES:

- A. Labels of Underwriters' Laboratories, Inc.; Certified Ballasts Manufacturers, and Electrical Testing Laboratories affixed to each item of material.

PART 2 - PRODUCTS**2.1 ACCEPTABLE FIXTURE MANUFACTURERS:**

- A. Listed in schedule and with materials.

2.2 POLE LIGHTING FIXTURES:

- A. Luminaire Assembly/Hardware -
 1. Luminaires shall be fully assembled and individually tested prior to shipment.

2. Luminaire housing and door shall be one piece die cast aluminum construction. The housing shall be designed to prevent the buildup of water and debris on the top of the housing. Access to the internal housing and electrical components shall be toolless by use of two recessed stainless steel latches. Door frame shall swing down and be retained by two catch hinges. Drivers and surge module shall be separated from the optical chamber by a cast in wall to allow for cooler operation. Luminaire shall include an extruded aluminum bolt on arm bracket for mounting to round or square poles.
 3. The maximum weight of the luminaire shall be 45 pounds and the maximum effective projected area shall not exceed 1.30 with mounting bracket.
 4. Manufacturers of LED luminaires shall demonstrate a suitable testing program incorporating high heat, high humidity and thermal shock test regimes to ensure system reliability and to substantiate lifetime claims.
 5. The sole use of IESNA LM-80 data to predict luminaire lifetime is not acceptable.
 6. At time of manufacture, electrical and light technical properties shall be recorded for each luminaire. At a minimum, this should include lumen output, CCT, and CRI. Each luminaire shall utilize a unique serial numbering scheme. Technical properties must be made available for a minimum of 5 years after the date of manufacture.
 7. Luminaires shall be provided with a 5 year warranty covering LEDs, drivers, 10kV surge module, paint finish and electrical connectivity.
 8. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver.
 9. Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night at 40°C (104°F).
 10. The rated luminaire operating temperature range shall be -30°C (-22°F) to +40°C (104°F).
 11. Each luminaire shall be capable of operating above 104° F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
 12. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or approved equivalent standard from a nationally recognized testing laboratory.
 13. Luminaire housing shall be UL wet location listed.
 14. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect the optical components.
 15. Housing and door frame shall be die cast aluminum with a nominal 2.5 mil thick paint finish able to withstand a 3,000 hour salt spray test as specified in ASTM Designation B117.
 16. Each refractor or lens shall be made from UV inhibited high impact optical grade acrylic and be resistant to scratching.
 17. Luminaire shall have a minimum initial efficacy of 84 lumens per watt and shall consume no more than 146 watts. The luminaire shall not consume power in the off state.
- B. LEDs and Drivers:
1. As specified below.
- C. Aluminum or steel lighting poles, as scheduled (base mounted):
- a. All poles with concrete base shall be designed to withstand the bending and overturning moment created by the wind loading of the entire pole and mounted

assemblies (EPA) and eccentricity caused by deflections under design wind loads. The design wind loading shall utilize an 80 MPH wind with a 1.3 gust factor. All portions of concrete pole bases shall be constructed in accordance with other specification sections.

- b. Poles shall be fabricated from aluminum or steel, as scheduled, and shall have an electrical cable passageway through the center. Poles shall receive a baked, electrostatically applied powder paint finish with a primer coat and a finish coat.
- c. Poles shall be provided with base access hole with cover above the pole base.
- d. Lightning protection shall be provided for each pole. A dual rated grounding lug shall be provided at the pole bottom hand hole. This grounding lug shall be electrically and mechanically connected to the pole metal.
- e. Pole accessories:
 - 1) A handhole frame shall be centered above the pole base. Cover in round poles shall be curved.
 - 2) A UL grounding lug shall be bonded to the inside of the pole across from the pole base handhole.
 - 3) Factory installed vibration dampener.
- f. Grounding: A #6 stranded copper ground wire shall be attached to an internal lug and connect a 5/8" x 10' UL listed ground rod unless diagrammed or scheduled otherwise.
- g. Pole Handling and Erection:
 - 1) Transportation, site handling and erection shall be performed by qualified personnel with equipment and methods that are in accordance with standard industry practices.
 - 2) Prior to unloading the pole, shop drawings shall be reviewed to identify proper pick-up points for unloading, storage and erection procedures.
 - 3) Internal wiring may be installed while pole is in horizontal position on the ground.

D. Acceptable Manufacturers:

1. Eaton-Lumark, Hubbell, Lithonia Architectural.

2.3 LEDs AND DRIVERS:

A. LEDs and Thermal Management:

1. Luminaire shall be manufactured with LED's provided by Philips Lumileds, Cree, Nichia or Citizen. LEDs shall have a Correlated Color Temperature (CCT) of 4,000K +/-275K. The color rendition index (CRI) shall be a nominal 70. Binning of the LEDs shall conform to ANSI/G, NEMA SSL 3-2010. Drive current to the LEDs shall not exceed 350mA.
2. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
3. The luminaire shall be constructed such that LED modules may be replaced or repaired without replacement of the whole luminaire.

4. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
5. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
6. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
7. The luminaire shall have a minimum heat sink surface such that the LED manufacturer's maximum junction temperature is not exceeded at the maximum rated operating temperature.
8. The heat sink material shall be aluminum.

B. Drivers:

1. LED Drivers and Surge Supression :
 - a. The driver shall operate from 60 HZ+/-3HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. Power factor shall be .90 or greater. Total harmonic distortion (current and voltage) induced into the AC power line shall not exceed 20 percent. Drivers must meet Class A emission limits referred in Federal Communications Commission Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise. Drivers shall be an IP66 rated UL class 2 power unit as per UL 1310.
 - b. Surge Suppression: The luminaire on-board circuitry shall include surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common and differential mode transient peak currents up to 10 kA (minimum). SPD conforms to UL 1449. SPD performance has been tested per procedures in ANSI/IEEE C62.41-2:2002 category C high exposure and ANSI C136.2 10kV BIL. The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect drawings and specifications.
- B. Inspect site and existing construction for defects affecting the quality and execution of work.

3.2 PREPARATION:

- A. Layout exact locations of poles and fixtures in accordance with plans, fixture details and supports. Obtain approval from Architect for layout locations.

3.3 LIGHTING POLE INSTALLATION:

- A. Excavation:
 - 1. The Contractor may excavate by any means he prefers, insofar as these methods conform to these specifications.
 - 2. The bottom of the pole base holes shall be on undisturbed earth. If a pole hole is excavated to a depth greater than required, it shall be backfilled with graded crushed rock, placed in 6" layers, and thoroughly machine tamped to density of surrounding soil.
 - 3. The Contractor shall immediately notify the Architect of any abnormal conditions discovered during excavation that may affect the installation.
- B. Plumb poles to vertical.
- C. Provide lighting fixtures, switches, and control systems, and wiring.
- D. Install in accordance with manufacturer's instructions, submittal data, and details on the drawings.

3.4 ADJUSTMENT AND CLEANING:

- A. Adjustment: Adjust internal reflectors and/or lamp positions for desired effects. Align fixtures with layout or building walls.
- B. Cleaning: Remove dirt, grease, and foreign materials from interior and exposed of all fixtures.
- C. Touchup marred finishes with manufacturer supplied paint or coating material to the satisfaction of the Architect. Poles with excessive damage to finish shall be replaced.
- D. The Contractor shall be responsible and bear all costs for remedy of deficient performance or installation.

3.5 LIGHTING FIXTURE SCHEDULE: Refer to drawings for fixture schedule.

END OF SECTION 26 51 00

SECTION 27 88 00 - INTERCOM SYSTEMS

PART 1 - GENERAL

1.1 SCOPE:

- A. This specification provides the requirements for the installation, programming and configuration to expand the existing Intercom and clock system to the building addition. The system shall include, but not limited to: telephones, annunciators and clocks as shown on the plans, and all other equipment necessary to provide a complete and operating system.
- B. The intercom system shall, as a minimum, incorporate all new devices shown on the plans.
- C. The Communication system shall provide distribution of intercom, overhead paging, emergency paging, class change time tones, emergency tone and program material.
- D. The requirements of Section 26 01 00, Basic Electrical Requirements, apply to this work.

1.2 QUALITY ASSURANCE:

- A. Equipment:
 - 1. Equipment assemblies shall be factory assembled and tested as a complete unit to meet the requirements of this system.
 - 2. All equipment shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.
 - 3. The Manufacturer shall be a nationally recognized company specializing in intercom systems. This organization shall employ factory trained technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the intercom systems industry.
 - 4. Manufacturers/model numbers listed herein shall be the basis of design. Equivalent equipment provided by acceptable manufacturers may be submitted for approval.
 - 5. The intercom system shall have a distributed communication architecture.
 - 6. Acceptable Manufacturers: Carehawk, Bogen, Simplex.
- B. Bidders:
 - 1. Bids by Wholesalers, Contractors, Franchised Dealers or any firm whose principal business is not that of manufacturing or installing intercom systems shall not be acceptable.
 - 2. The bidder shall have an in-place support facility with technical staff, spare parts inventory and all necessary test and diagnostic equipment. The installer shall have a resident fully qualified service organization equipped for on-site maintenance and repair within a 100 mile radius of the site.
- C. Installer:
 - 1. The system shall be installed by competent technicians, regularly employed by the intercom manufacturer with full responsibility for proper operation of the intercom

- system including debugging and proper calibration of each component in the entire system.
2. Supplier and installer shall be able to refer to similar installations in the immediate area furnished and serviced by him during the past three years, providing satisfactory service.
 3. Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.
 4. Manufacturer's Representative: Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.

1.3 SUBMITTALS:

- A. Shop Drawings: Submit manufacturer's literature completely describing intercom system components, equipment, and accessories, and shop drawings illustrating system interconnecting wiring and connections.
 1. The contractor shall include the following information in the equipment submittal:
 - a. Complete wiring diagrams that illustrate the wiring requirements for each component in the proposed system.
 - b. Equipment list of all proposed devices and equipment.
 - c. Manufacturer's catalog data cut sheets on all equipment being provided for a fully functional system.
 - d. Software and firmware as required to provide a complete functioning system.
 - e. FCC registration number.
- B. Instructions: Furnish Instruction Manual describing operation of intercom system.
- C. Documentation:
 1. Software documentation including description of programmed operation.
 2. Submit maintenance brochure after completion of the project. Maintenance brochure shall include operating instructions, specifications, and instruction sheets for the equipment.
 3. A complete list identifying all specific deviations from the specified system components and operation.
- D. See Section 26 01 00.

PART 2 - PRODUCTS

2.1 VOICE COMMUNICATION AND SOUND SYSTEM:

- A. Furnish and install a microprocessor controlled voice communication system with all conduit, wire, outlets and equipment as shown on the drawings and as herein specified to provide a complete intercom, program and tone distribution and clock system in the building.

- B. The integrated communication system shall be interfaced with the Owner's telephone system. Provide this work coordinated with the owners' telephone system provider.

2.2 SYSTEM OPERATION AND FEATURES:

- A. The integrated communications system shall be a multi-channel, microprocessor controlled communications system. The system shall be capable of simultaneously handling intercom, program, and paging distribution using administrative telephones APIs connected to the intercom system and from selected telephones connected to the owner's telephone system. The system shall provide the ability to operate and correct digital and/or analog clocks. The system shall provide the ability to distribute tones to different areas of the building and activate other devices or systems based on the time of day, system activity or event. The system shall provide up to two independent intercom channels between administrative telephones and loudspeaker(s). One additional simultaneously operating channel shall be provided for distribution of program material. Systems not providing a minimum of two, simultaneous open voice (administrative telephone to speaker) speech paths shall be unacceptable.
1. System shall provide user programmable architectural room numbering assignments.
 2. Calls placed from the call-in switch in the classroom shall display the numeric room number of the classroom placing the call and priority of the call on the administrative telephones connected to the intercom system.
 3. System shall contain a minimum of 64 Multipurpose Zones, which can be assigned and programmed as desired between paging, program, or time zones.
 4. The system shall allow future expansion of the program channels to a total of two individual channels.
 5. The system shall provide integration with the owner provided telephone system that will allow owner provided telephones to handle calls from telephones connected to the owner provided telephone system as well as calls placed from the intercom call-in switches.
 - a. Owner provided telephones shall also have the ability to call individual classroom speakers and establish a two way conversation with that classroom and make zone, all call and emergency pages over the intercom system speakers.
 - b. Additional equipment and programming that may be required by the owners telephone system shall be the owners' responsibility.
- B. The system shall be equivalent to the Carehawk CH1000 integrated communications system.
- C. The system shall have the capability for modular capacities of 256 audio ports with associated call-in point.
1. All port locations may be assigned to a 3, 4, 5 or 6 digit dial number as available on industry standard telephone keypad.
 2. The system shall be expandable in groups of ports.
- D. The system shall provide a minimum of 25 system tones and 25 user configurable tones.
1. The system shall allow the user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce tones, or any other system tone. Intercom systems not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

- E. The system shall provide one multiple input source, program distribution channel. This program shall be programmed and distributed from any administrative telephone. Systems that require manually operated switchbanks to distribute program material shall not be acceptable.
- F. The system shall have 64 user assignable groups for zoned audio paging, class change signals, or program distribution, with any speaker belonging to all zones, some zones or no zone.
1. Paging may originate from any administrative telephone, telephone on the owners telephone system or a dedicated paging microphone (if provided), or program source input.
 2. System software shall allow loudspeakers in the immediate vicinity of the administrative telephone making the page to be excluded from that page to prevent feedback.
 3. An administrative telephone may be associated directly with a loudspeaker by assigning them the same dial number
 4. The system shall include Page or Intercom priority over class change tones and pre-programmed events.
 - a. Class change tones occurring simultaneously with All Page or Zone Page shall be programmable to be delayed until the active page has concluded.
 5. The system shall utilize the industry standard 25V method of transmission.
 6. Each loudspeaker may be a member of up to 64 multipurpose zones.
- G. The system shall provide up to two simultaneously operating open voice intercom channels between administrative telephones and classroom speakers.
1. Communications from the classroom loudspeaker shall be hands free. The staff member in the classroom need not operate any buttons to reply to a call. The system shall use the automatic VOX operation to switch between the talk and listen modes.
- H. All audio functions in the system operate within the following priority scheme.
1. A Lower priority function cannot interrupt a higher priority event.
 2. A Lower priority event may be interrupted by a higher priority event.
 3. Interrupted lower priority functions (automatic) will be restored after conclusion of the higher priority function.
 - a. If an event is initiated while a Page is occurring, the event will be optionally delayed until the Page is complete.
 4. The following priorities are ranked from highest to lowest.
 - a. An emergency page suspends all other audio
 - b. An emergency tone suspends all other audio except the above
 - c. A normal page suspends all other audio except the above
 - d. A tone suspends all other audio except the above
 - e. A program source audio event suspends nothing
 - f. Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
 5. A group of loudspeakers may be temporarily excluded from receiving Time, Page or Program distribution by temporarily removing the desired station(s) stations from a pre-programmed zone. This feature shall be enabled/disabled from any administrative telephone programmed to allow access to this function.
 6. The initiator may cancel this exclusion at any time.

7. A temporary exclusion shall automatically return to the pre-programmed status before the start of class the next day.
 8. A group of loudspeakers may at the users discretion be permanently excluded.
- I. The system shall contain a flexible database capable of addressing each system loudspeaker and call-in switch and assigning unique parameters to each.
1. System programming shall be via a PC.
 - a. The user may choose to perform these programming functions via an already installed PC on-site or remotely from off-site.
 - b. Off-site programming and diagnostics shall be accomplished via the internet.
 - 1) Provide owner with an electronic copy of; bell schedule, architectural room number information, zone assignments for paging and current bell schedules, dial numbers for all administrative telephones. Access to this information shall be from a standard PC with Windows version 7 or higher.
- J. The system shall contain an integral master clock which shall be capable of performing the following functions.
1. Provide unlimited discrete time event entries and unlimited schedules for programming functions based upon;
 - a. The time of day in hours and minutes.
 - b. The date the event is to occur.
 - c. Selection of any one or any combination of sixty-four zones to be activated.
 - d. Selection of any one or combination of outputs to be activated.
 - e. Selection of any one or combination of an unlimited number of schedules to allow for maximum flexibility due to special circumstances or seasonal changes.
 - 1) Any combination of an unlimited number of time schedules may be active simultaneously.
 - f. Time tone event type.
 2. The system shall provide twenty-five (25) system time tone types and allow users to add up to twenty-five (25) WAV files to be used as event tones.
 3. The master clock shall provide for automatic daylight savings time and leap year adjustments.
 4. The master clock shall provide the ability to interface with an external master clock to allow the two systems to synchronize.
 5. Master clock shall correct compatible secondary clocks, analog or digital or both.
 6. The system shall include calendar based software that allows the user to create, edit and review an unlimited number of events and schedules. Intercom systems that provide scheduling of events by only the day of the week and not on a calendar basis shall not be considered.
 7. The system shall support "March to Music" allowing pre-selected program material to be distributed according to pre-programmed schedules.
 8. The intercom system master clock shall be capable of being synchronized by a Network Time Sever (NTP). Intercom systems that do not synchronize to a NTP server shall not be considered.

- K. The system shall provide, as a part of the processor card, five open collectors, three dry contacts, and six general purpose inputs for interface with external devices and/or systems. Systems not providing these inputs and outputs shall be unacceptable.
1. Inputs shall be programmable by the user to initiate any desired system activity (e.g. page, tone, program, event, system reset, clock synchronization, alarm etc.)
 2. Outputs shall be programmable by user to activate during any desired system activity (e.g. intercom, page, tone, program, time of day, etc.). Outputs may also be manually activated from any administrative phone.
- L. The system shall contain self-diagnostics to continually monitor the systems integrity. The system shall be provided with a user-friendly interface for system programming and diagnostics. The GUI will be Windows® based and will run on any compatible PC that supports Windows®.
1. User or Service Technician may download or upload complete system configuration data and store on a diskette. All system programming shall be stored on the disk for future use. This information may be reloaded at any time either on-site or from a remote location.
 2. A copy of the programming and diagnostic software shall be provided to the owner and installed on the Owner's PC as part of this contract.

2.3 SYSTEM EQUIPMENT:

A. SECURITY SWITCHING CARD

1. The intercom system shall use distributed security switching cards for connection to all system speakers and call-in switches.
2. Security switching cards shall be centrally powered from the intercom system central cabinet at distances up to 2700 feet using a single cat 5e cable.
3. Security switching cards shall provide RJ45 terminations for field wiring.
4. Security switching cards shall contain 16 or 32 audio ports
5. Each audio port shall support bidirectional audio communications with the central cabinet and AP1 administrative telephone(s) as well as multiple contact closure inputs.
6. Security switching cards shall be equivalent to Carehawk model SS16 (16 port) or Carehawk model SS32 (32 port)
7. Intercom systems that do not use a distributed architecture or require networking of multiple central systems to be distributed shall not be considered. Intercom systems that require the use of Ethernet components to bridge the 2700 foot distance shall not be considered.

B. AMPLIFIERS

1. The intercom system amplifier shall be equivalent to Carehawk DAF250 Class D digital amplifier with at least 250 Watts RMS and 300 Watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. Intercom systems using Class B amplifiers or amplifiers not capable of 0.2% maximum distortion shall not be considered.
2. The Class D amplifier shall be direct drive 25V constant voltage type. Intercom systems using transformer based amplifiers shall not be considered.
3. The intercom system shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility. Intercom systems not using a DSP shall not be considered.
4. The intercom system shall have 45 Ohm conversion modules available on a switching/line cards basis to convert the 25V audio signal to 45 Ohm for use with 45 Ohm speakers.

Intercom systems not capable of conversion to 45 Ohm audio on a switching/line card basis shall not be considered.

5. The intercom system amplifiers shall go to sleep thus reducing their current draw when not in use. Intercom systems that use amplifiers that do not reduce their current draw when not in use shall not be considered.
6. The intercom system amplifiers shall have a built in pink noise generator for testing speaker quality and audio levels. Intercom systems that do not contain a pink noise generator shall not be considered.

C. LOUDSPEAKERS, BAFFLES AND BACKBOXES

1. Flush Mounted Ceiling Speakers.

- a. The loudspeaker shall be a dual cone 8-inch speaker shall be equivalent to Lowell Model No. 810-T72 which shall be of the permanent magnet type having a seamless molded fiber cone with a hard fiber whizzer cone mechanically coupled to a voice coil for extended high frequency response. Power rating shall be 15 watts RMS. The voice coil shall have a 1-in. dia. and shall operate in a magnetic field derived from a strontium ferrite (ceramic) magnet having a nominal weight of 10 oz. Voice coil impedance shall be 8ohms. The mounted transformer shall be 70/25V dual voltage with selectable taps at .25, .5, 1, 2, and 5W. The assembly shall be capable of producing a uniform audible frequency response over the range of 51Hz-11.6kHz (+6dB), 50Hz- 20kHz (+6.4dB) with dispersion angle of 95 degrees conical @2000Hz (-6dB).
- b. The loudspeaker baffle shall be equivalent to Lowell Model WB-8. It shall be fabricated one-piece 20-gauge steel reinforced with a peripheral flange of 60-degrees. The grille diameter shall be 12.875" with a shallow mounting projection of 0.25". Each grille shall have four 0.25" holes spaced at 90-degree intervals on an 11.25" bolt circle for mounting grille to specified backbox or mounting ring. It shall be finished in white powder epoxy coating and include white screws for backbox mounting and welded studs for mounting specified 8" speaker.
- c. The enclosure for recessed installation of an 8 in. driver shall be equivalent to Lowell Model No. 8XD4, which shall be fabricated of certified U.S. steel and have a white powder epoxy finish. The unit shall have a diameter of 10 inches and a depth of 4 inches. It shall include a polyurethane foam disc that is UL Listed to meet flammability CAL-117 for resonance and vibration control. The enclosure shall also feature one planished (0.5 in.) knockout on top and four (0.5 to 0.75 in.) knockouts on sides (spaced at a 90-degree interval).

2. Surface Mount Speakers

- a. The surface-mount backbox shall be equivalent to Lowell Model CB84-SG, which shall be fabricated of 20-gauge steel and lined with 1.5" acoustic batting. The rear shall include provisions to mount a 4" square, 4" octagon, 2-gang or 1-gang E.O. box (not included). The rear shall also have a 0.375" diameter hole with grommet for wire access. Two sides shall have knockouts for 500 Series wire mold. The backbox shall measure 11.5" square x 4" deep and have a white powder epoxy finish. It shall feature four holes and 8-32 U-clips at flanged corners to accept a screw-mount grille (order separately). The grille for the 8" speaker shall be Lowell Model SG-8. It shall be formed with 22-gauge steel, have beveled edges and a square punched center. The grille shall be 11.438" square with a mounting projection of 0.125". It shall include a chipboard gasket and 8-32 x 3/4" welded

studs with hex nuts to mount the specified 8" speaker. Grille shall also have four 0.218" holes on 9.062" centers to mount specified recessed or surface backbox. Grille shall be finished in white powder epoxy and shall include white screws for backbox installation.

- b. The loudspeaker shall be a dual cone 8-inch speaker equivalent to Lowell Model No. 810-T72 which shall be of the permanent magnet type having a seamless molded fiber cone with a hard fiber whizzer cone mechanically coupled to a voice coil for extended high frequency response. Power rating shall be 15 watts RMS. The voice coil shall have a 1-in. dia. and shall operate in a magnetic field derived from a strontium ferrite (ceramic) magnet having a nominal weight of 10 oz. Voice coil impedance shall be 8ohms. The mounted transformer shall be 70/25V dual voltage with selectable taps at .25, .5, 1, 2, and 5W. The assembly shall be capable of producing a uniform audible frequency response over the range of 51Hz-11.6kHz (+6dB), 50Hz- 20kHz (+6.4dB) with dispersion angle of 95 degrees conical @2000Hz (-6dB).
3. Horn Type Speakers
 - a. The horn shall be equivalent to Lowell Model LH-15TA, which shall be a double reentrant design with a high efficiency 15W compression driver, round bell and universal swivel-style base. Power rating shall be 15 watts continuous. Frequency response shall be 537Hz-4.5kHz (+6dB) with a sensitivity of 112.2dB log average (1W/1M) 124.0dB maximum SPL (calculated based on power rating and measured sensitivity). Dispersion shall be 50 degrees conical (2kHz Octave Band). Impedance shall be 5000, 2500, 1300, 670, 330, 90, 45 ohms. Horn shall include a 25/70/100V transformer with screwdriver selectable taps. Taps for 25V use shall be: .13, .25, .48, .93, 1.9, 6.9, and 13.9W. Taps for 70V use shall be: 1, 2, 3.8, 7.5, and 15W. Taps for 100V use shall be: 2, 4, 7.7 and 15W. Transformer connections shall be protected by a plastic cover with strain relief. The horn assembly shall measure 8.94" dia. x 9.38" deep and shall be weather-resistant metal construction painted in corrosion-resistant beige epoxy.

D. CLOCKS

1. Analog Clocks

- a. The analog clock shall be equivalent to Sapling model SAL-2BS-12R-0 wireless battery operated clock with a black hour hand, a black minute hand, and a red second hand. The clock will be capable of receiving and then re-transmitting a signal from any other Sapling device that transmits data using Sapling's wireless protocol. The clock shall use frequency-hopping technology to receive time data on a frequency range of 915-928 MHz. The clock shall also be able to retransmit time data on the same frequencies. The frequency-hopping technology shall allow the clock to transmit time data without causing interference to other wireless devices that may be transmitting at the same time. The clock shall be designed to be used with the Sapling SMA Series Master Clock (with the transmitter option installed) or the Sapling Repeater. Time data shall be transmitted and received by the clock via Sapling's wireless communication protocol. The clock shall also be designed to receive and retransmit time data to Sapling's SBL Series clocks and other SAL Series clocks. Upon receipt of the wireless signal, the clock will immediately self-correct. The clock's transmitter shall be able to successfully transmit data over a line-of-sight, unobstructed distance of up to 1320 feet.

- b. The clock shall include an executable method for automatic hand calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, the performance and results of a gearbox test, and a comprehensive analysis of the entire clock movement. These diagnostic functions shall be enabled by pressing a button on the clock movement.
 - c. The clock shall require fewer than five (5) minutes to perform a correction of the hand positions.
 - d. The clock shall be capable of receiving a time and correction signal every two (2) hours in standard mode and every four (4) hours in economy mode.
 - e. The battery life of the clock shall be five (5) hours in standard mode and eight (8) hours in economy mode.
 - f. The clock shall have a smooth surface ABS case which can be attached either directly to the wall, or to a standard-sized gang box.
 - g. The crystal is to be made of shatterproof, side molded polycarbonate.
 - h. The clock shall be FCC compliant, in accordance with part 15 Section 15,247.
 - i. Analog clocks shall be set to operate in the economy mode.
 - j. Batteries for wireless battery operated clocks shall be included as part of this bid.
- E. WIRE AND CABLE
1. Plenum rated cable as specified by product manufacture.
- F. CALL-IN SWITCHES
1. Call-n switches shall be equivalent to Carehawk model CS45. The CS45 has a momentary call-in button to provide a method to initiate a normal intercom call (single press) or an emergency intercom call (double press) that is received by the AP1 Administrative Phone.
 - a. The CS45 call-in switch shall also provide a latching privacy feature to allow the user to prevent unauthorized eavesdropping.
 - b. The CS45 interfaces with a SS16/SS32 Security Switching Card audio port.
 - c. The CS45 provides pig tail connectivity for a cable from the SS16/ SS32 Security Switching Card port and classroom loudspeaker.
 - d. Construction shall consist of rocker-type push button mounted to brushed stainless steel plate for durability.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. The Intercom system shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner. The Contractor shall be responsible for all electrical installation required for a fully functional intercom system. All wiring shall be in accordance to all local and national codes. All line voltage wiring and all wiring in equipment rooms shall be installed in conduit and in accordance with NEC and local codes.
 1. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of intercom systems.
- B. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations.

1. All intercom system wiring shall be in a completely separate conduit system, except where cable is allowed below. All circuitry shall be concealed in walls and above ceilings.
 2. Wiring color code shall be maintained throughout the installation. All new wiring shall have each conductor tagged and identified. Wiring for like functions shall be color-coded consistently throughout the systems.
 3. Verify all circuiting requirements with equipment manufacturer before installation.
- C. All circuitry shall be properly supported and run in a neat and workmanlike manner. All circuitry shall run parallel to or at right angles to the building structure. All wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All electronic wiring shall be type and size as recommended by system manufacturer.
1. Where installed above accessible ceilings, intercom cabling may be installed in a neat manner, tightly bundled and independently secured to building structure by approved means. Do not lay cable on ceiling and do not support from other conduit systems, ductwork or piping. Utilize plenum rated cable in return air plenums.
 2. Where devices are to be installed on, or cabling is to pass through frame walls or hollow masonry walls the cabling shall be fished in the wall cavity to an appropriate flush outlet box firmly mounted in the wall.
 3. Where devices are to be installed on or cabling is to be routed over solid masonry walls the cabling shall be installed in approved surface mounted raceways equal to Wiremold or equivalent. Where installed in rooms with accessible ceilings the surface raceways shall be routed vertically from the ceiling to the device in a neat and workman like manner. Verify all routing of surface raceways with the Architect.
 4. Where approved surface mounted raceways are used, the device mounting boxes shall be finished surface boxes of suitable size for the device installation.
- D. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the intercom contractor at no charge to the Owner during the warranty period.
- E. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.
- F. The intercom contractor shall maintain electronic copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the Owner during training session, and one copy shall be archived by the intercom manufacturer.
- G. The contractor shall clean all dirt and debris from the inside and the outside of all system equipment after completion of the installation.

3.2 CLEANING:

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

3.3 FIELD QUALITY CONTROL AND TESTING:

- A. **Manufacturer's Field Services:** Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
 1. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of intercom systems.
- B. **Coordinate the testing during occupied hours with the Owner to minimize disruption of the daily schedule.**
- C. **Pretesting:** Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- D. **Final Test Notice:** Provide a 10-day minimum notice in writing to the Architect when the system is ready for final acceptance testing.
- E. **Retesting:** Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- F. **Report of Tests and Inspections:** Provide a written record of inspections, tests, and detailed test results in the form of a test log.

3.4 INSTRUCTION:

- A. All training shall be by the Intercom manufacturer's trained representative and shall utilize Operation and Maintenance manuals and as-built documentation. Manual documentation shall include:
 1. Operation sequences with specific to specific hardware components - Wiring diagrams
 2. System software documentation.
 3. Operation instructions.
 4. Maintenance instructions.
 5. Troubleshooting instructions.
- B. Following the completion of work, the Owner's representative shall be given a minimum of two (2) two hour sessions of instructions on operation and maintenance of the completed system. Training topics shall include:
 1. Sequence of Operation review.
 - a. Operating station equipment.
 - b. Administrative devices.
 - c. User programming functions.
 - d. Program distribution equipment.
- C. Deliver to the Owner at the time of the first training session three complete Operation and Maintenance Manuals.

3.5 WARRANTY:

- A. The contractor shall warrant the completed intercom system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one year from the date of the completed and certified test or from the date of first beneficial use.
- B. A representative of the manufacturer shall provide at least two inspections of the complete system during the one year warranty period.
- C. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the intercom contractor at no charge to the Owner during the warranty period.
- D. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks. All firmware or resident software updates and new releases shall be supplied and installed free of charge for two years after the project warranty is expired.
- E. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines, to begin after the warranty period expires.

END OF SECTION 27 88 00

SECTION 28 72 10 - FIRE ALARM SYSTEMS**PART 1 - GENERAL****1.1 SCOPE:**

- A. This specification provides the requirements for the installation, programming and configuration of a complete Addressable Fire Alarm System. The system shall include, but not limited to: fire alarm control panel, power extenders where required, automatic and manually activated alarm initiating and notification peripheral devices, conduit and wiring, software and accessories required to furnish a complete and operational Life Safety System. The installed Fire Alarm System shall provide complete automatic and manual fire detection and alarm notification as required for this facility.
- B. The complete installation shall conform to the applicable sections of NFPA-72, Local Code Requirements and National Electrical Code [Article 760].
- C. System shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- D. The fire alarm control panel shall, as a minimum, incorporate all new devices shown on the plans.
- E. The requirements of Section 26 01 00, Basic Electrical Requirements, apply to this work.

1.2 FIRE ALARM SYSTEM DESCRIPTION:

- A. General: Provide a complete, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
- C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history.
- D. Wiring/Signal Transmission:
 - 1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
 - 2. System connections for initiating, signaling line circuits and notification appliance circuits shall be Class B.

3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- E. Remote Access:
1. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.
 2. FACP shall have the capability to provide third party access through a serial interface connection and be agency listed for specific interfaces and for the purpose.
- F. Required Functions: The following are required system functions and operating features:
1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
 2. Noninterfering: An event on any initiating addressable device does not prevent the receipt of signals from any initiating devices. All addressable initiating devices are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
 3. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided **under another contract**.
 4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.
 5. General Alarm: A system general alarm shall include:
 - a. Indication of alarm condition at the FACP and the annunciator(s).
 - b. Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
 - c. Operation of audible and visible notification devices throughout the building until silenced at FACP.
 - d. Closing doors normally held open by magnetic door holders.
 - e. Unlocking designated doors.
 - f. Shutting down supply and return fans serving zone where alarm is initiated.
 - g. Closing smoke dampers on system serving zone where alarm is initiated.
 - h. Notifying the local fire department.
 6. Supervisory Operations: Upon activation of a supervisory device such as fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.

- b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of supervisory signal to remote central station.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
 7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible [and visible] alarm signals shall cease operation.
 8. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state.
 - b. Should an alarm condition continue, the system will remain in an alarmed state.
 9. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
 10. WALKTEST: "One Person Testing" mode of the system as follows:
 - a. The city circuit connection and any suppression release circuits shall be bypassed.
 - b. Control relay functions associated to one of the 8 testing groups shall be bypassed.
 - c. The control unit shall indicate a trouble condition.
 - d. The unit shall automatically reset itself after signaling is complete.
 - e. Any opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- G. Analog Smoke Sensors:
1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 3. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
 4. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning.
 5. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.]
- H. Audible Alarm Notification: By horns and horn/strobe units in areas as indicated on drawings.
- I. Fire Suppression Monitoring:
1. Water flow: Activation of a water flow switch shall initiate general alarm operations.

2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.

J. Power Requirements

1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
2. The Fire Alarm system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.3 QUALITY ASSURANCE:

A. Equipment:

1. Equipment cabinet assemblies shall be factory assembled and tested as a complete unit to meet the requirements of this system.
2. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.
3. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.
4. Fire alarm systems by the manufacturers listed below will be considered. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
5. Acceptable Manufacturers: Honeywell Inc., Fire Lite, Gamewell, Notifier, Siemens, Silent Knight, Simplex Grinnell.

B. Bidders:

1. Bids by Wholesalers, Contractors, Franchised Dealers or any firm whose principal business is not that of manufacturing or installing fire alarm systems shall not be acceptable.
2. The bidder shall have an in-place support facility with technical staff, spare parts inventory and all necessary test and diagnostic equipment. The installer shall have a resident fully qualified service organization equipped for on-site maintenance and repair within a 100 mile radius of the site.

C. Installer:

1. The system shall be installed by competent electricians, regularly employed by the fire alarm manufacturer with full responsibility for proper operation of the fire management system including debugging and proper calibration of each component in the entire system.
2. Supplier and installer shall be able to refer to similar installations in the immediate area furnished and serviced by him during the past three years, providing satisfactory service.
3. The contractor shall employ on staff a minimum of one NICET level II technician or a professional engineer, registered in the State of the installation.
4. Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.
5. Manufacturer's Representative: Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
6. The final checkout and verification of the Fire Alarm system shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET). This technician shall be registered as level 2 or higher in the fire protection technology certification program. Provide NICET certification information with fire alarm submittal.

D. Codes and Approvals:

1. The complete fire management installation shall be in strict accordance to the Uniform Fire Code and all local and state codes having jurisdiction for fire alarm/life safety systems. All devices designed for or used in line voltage applications shall be UL listed.
2. All microprocessor based remote devices shall be UL916 and UL864 Listed.
3. All fire management central equipment shall be UL916 Listed.
4. Other fire alarm equipment shall be listed under the appropriate following UL standards.

E. All system components shall be fault tolerant. They shall provide satisfactory operation without damage at 110% of rated voltage and at ± 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs as required. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be ac coupled or equipped with equivalent

preventative measures so that any single device failure will not disrupt or halt bus communication.

1.4 SUBMITTALS:

- A. Shop Drawings: Submit manufacturer's literature completely describing fire alarm system components, equipment, and accessories, and shop drawings illustrating system interconnecting wiring and connections.
1. The contractor shall include the following information in the equipment submittal:
 - a. AutoCAD floor plans and complete wiring diagrams that illustrate the wiring requirements for each component in the proposed system.
 - b. Power calculations including battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement.
 - c. Equipment list of all proposed devices and equipment.
 - d. Manufacturer's catalog data cut sheets on all equipment being provided for a fully functional system.
 - e. Software and firmware as required to provide a complete functioning system.
 2. When required by the State Fire Marshal, Fire Alarm Shop Drawings shall bear the stamp of an engineer licensed in the State of Kansas.
- B. Instructions: Furnish Instruction Manual describing operation of fire alarm system.
- C. Documentation:
1. Software documentation including description of programmed operation.
 2. Submit maintenance brochure after completion of the project. Maintenance brochure shall include operating instructions, specifications, and instruction sheets for the equipment.
 3. A complete list identifying all specific deviations from the specified system components and operation.
 4. See Section 26 01 00 for additional requirements.

1.5 EXTRA MATERIALS:

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
- B. Horn, Strobe, and Combination Units: Furnish quantity equal to 10 percent of the number of each type of unit installed, but not less than one.
- C. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
- D. Detector or Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.

PART 2 - PRODUCTS**2.1 FIRE ALARM CONTROL PANEL (FACP):**

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. The following FACP hardware shall be provided:
 - 1. Power Limited base panel with cabinet and door, 120 VAC input power.
 - 2. Minimum point capacity of 200% of designed system's point count, or a minimum capacity of 200 points, whichever is larger. Points shall include any addressable initiating devices.
 - 3. Provide a digital dialer in compliance with 2009 International Building Code requirements.
 - 4. Programmable DACT for either Common Event Reporting or per Point Reporting.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
 - 1. Cabinet color: red.
- D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

2.2 EMERGENCY POWER SUPPLY:

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 5 minutes.

2.3 REMOTE ANNUNCIATOR:

- A. Provide where required a remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.
- B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

- C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
- D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- E. The LCD shall display the following information relative to the abnormal condition of a point in the system:
 - 1. 40 character custom location label.
 - 2. Type of device (e.g., smoke, pull station, waterflow).
 - 3. Point status (e.g., alarm, trouble).
- F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.
- G. Device color: red.

2.4 ADDRESSABLE MANUAL PULL STATIONS:

- A. Description: Addressable single- or double-action type, LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Device color: red.

2.5 SMOKE SENSORS:

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - 1. Factory Nameplate: Serial number and type identification.
 - 2. Operating Voltage: 24 VDC, nominal.
 - 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - 4. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - 5. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type.
 - 6. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
 - 7. Sensors include a communication transmitter and receiver having a unique identification and capability for status reporting to the FACP.
- B. Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.

- C. Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
- D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 - 1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
 - 2. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
 - 3. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
- E. Device color: red.

2.6 HEAT SENSORS:

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing.
- D. Device color: red.

2.7 ADDRESSABLE CIRCUIT INTERFACE MODULES:

- A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of water flow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.
- C. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.8 MAGNETIC DOOR HOLDERS: None are used.

2.9 STANDARD ALARM NOTIFICATION APPLIANCES:

- A. Horn: Piezoelectric type horn shall be listed to UL 464. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.
- B. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- C. Audible/Visible: Combination Audible/Visible (A/V) Notification. Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Devices installed outdoors shall be weatherproof.
- D. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.
- E. For outdoor hazardous locations, provide weatherproof devices meeting the requirements of NFPA National Electrical Code.
- F. Device color: red.
- G. Accessories: The contractor shall furnish the necessary accessories.

PART 3 - EXECUTION**3.1 INSTALLATION:**

- A. The fire alarm system shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner. The Contractor shall be responsible for all electrical installation required for a fully functional fire alarm system. All wiring shall be in accordance to all local and national codes. All line voltage wiring and all wiring in equipment rooms shall be installed in conduit and in accordance with NEC and local codes.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.

2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 3. Personnel licensed or certified by state or local authority.
- C. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations.
1. All fire alarm system wiring shall be in a completely separate conduit system, except where cable is allowed below. All junction boxes shall be sprayed red and labeled "Fire Alarm". All circuitry shall be concealed in walls and above ceilings where the structure is not exposed.
 2. Wiring color code shall be maintained throughout the installation. All new wiring shall have each conductor tagged and identified. Wiring for like functions shall be color-coded consistently throughout the systems.
 3. Verify all circuiting requirements with equipment manufacturer before installation.
- D. Provide interconnecting wiring from fire alarm systems control outputs to controlled devices and equipment. Provide connection of power supplies and or transformers for powering controlled device operators.
1. Provide connections for operation and wiring from output contacts to smoke dampers operators.
- E. Equipment Installation:
1. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
 2. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
 3. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
 4. Do not install any area smoke sensor within 3 feet of an air supply or return grille.
- F. Wiring Installation:
1. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
 2. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
 3. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits

differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

- G. All circuitry shall be properly supported and run in a neat and workmanlike manner. All circuitry shall run parallel to or at right angles to the building structure. All wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All electronic wiring shall be type and size as recommended by system manufacturer.
1. Where installed above accessible ceilings, fire alarm cabling may be installed in a neat manner, tightly bundled and independently secured to building structure by approved means. Do not lay cable on ceiling and do not support from other conduit systems, ductwork or piping. Utilize plenum rated cable in return air plenums.
 2. Where devices are to be installed on, or cabling is to pass through frame walls or hollow masonry walls the cabling shall be fished in the wall cavity to an appropriate flush outlet box firmly mounted in the wall.
 3. Where devices are to be installed on or cabling is to be routed over solid masonry walls the cabling shall be installed in approved surface mounted raceways equal to Wiremold or equivalent. Where installed in rooms with accessible ceilings the surface raceways shall be routed vertically from the ceiling to the device in a neat and workman like manner. Verify all routing of surface raceways with the Architect.
 4. Where approved surface mounted raceways are used, the device mounting boxes shall be finished surface boxes of suitable size for the device installation.
- H. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the fire alarm contractor at no charge to the Owner during the warranty period.
- I. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.
- J. The Fire Alarm Contractor shall maintain electronic copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the Owner during training session, and one copy shall be archived by the fire alarm manufacturer.
- K. The contractor shall clean all dirt and debris from the inside and the outside of all system equipment after completion of the installation.
- L. Install additional audio/visual units in locations indicated to have inadequate sound levels based on the sound level testing.

3.2 CLEANING AND ADJUSTING:

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

- C. Do not install smoke detectors before the status of construction and clean-up meets the requirements of NFPA. Clean all smoke detectors at the completion of the construction work. Produce a log of all smoke detector sensitivity levels at system start-up and deliver to the Owner.

3.3 FIELD QUALITY CONTROL AND TESTING:

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Coordinate the testing during occupied hours with the Owner to minimize disruption of the daily schedule.
- D. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- E. Final Test Notice: Provide a 10-day minimum notice in writing to the Architect when the system is ready for final acceptance testing.
- F. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- G. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- H. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
- I. Final Test, Certificate of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.4 INSTRUCTION:

- A. All training shall be by the Fire Alarm manufacturer's trained representative and shall utilize Operation and Maintenance manuals and as-built documentation. Manual documentation shall include:
1. Operation sequences with specific to specific hardware components - Wiring diagrams
 2. System software documentation
 3. Control Panel operation instructions
 4. Maintenance instructions
 5. Troubleshooting instructions
- B. Following the completion of work, the Owner's representative shall be given a minimum of two (2) two hour sessions of instructions on operation and maintenance of the completed system. Training topics shall include:
1. Sequence of Operation review.
 2. Sign on-Sign off.
 3. Interpretation and selection of displays and reports.
 4. Modifying English text.
 5. Modifying alarm limits and start-stop times.
 6. System initialization.
 7. Purge and/or dump of historical data.
 8. Troubleshooting of sensors (determining bad sensors).
 9. Troubleshooting and selection of notification devices
- C. Deliver to the Owner at the time of the first training session three complete Operation and Maintenance Manuals.

3.5 WARRANTY:

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one year from the date of the completed and certified test or from the date of first beneficial use.
- B. A representative of the manufacturer shall provide at least two inspections of the complete system during the one year warranty period.
- C. Labor to troubleshoot, repair, reprogram, or replace system components shall be furnished by the Fire Alarm contractor at no charge to the Owner during the warranty period.
- D. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks. All firmware or resident software updates and new releases shall be supplied and installed free of charge for two years after the project warranty is expired.
- E. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines, to begin after the warranty period expires.

END OF SECTION 28 72 10

SECTION 31 20 00 - EARTH MOVING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, and pavements.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.

B. Related Requirements:

1. Section 01 32 00 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
2. Section 03 30 00 "Cast-in-Place Concrete" for vapor retarder installed above granular course and beneath the slab-on-grade.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving or cement concrete paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
 - d. Extent of trenching by hand or with air spade.
 - e. Field quality control.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Controlled low-strength material, including design mixture.
 - 3. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches (300 by 300 mm).

2. Warning Tape: 12 inches (300 mm) long; of each color.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 1. Classification according to ASTM D 2487.
 2. Laboratory compaction curve according to ASTM D 698.
- C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 01 50 00 "Temporary Facilities and Controls" are in place.
- E. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.

5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 1.5 inches (38 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
1. Groups GC, SC, and CL may be considered satisfactory if they meet the recommendations of the geotechnical report.
 2. Unsatisfactory soils also include satisfactory soils not maintained above optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with a maximum particle size of 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.
- J. Sand: ASTM C 33/C 33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- L. Low Volume Change Material (LVC): Consist of material with a liquid limit (LL) less than 40 and a plasticity index (PI) between 10 and 20; with minimum 15 percent passing a No. 200 sieve.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Survivability: As follows:
 - a. Grab Tensile Strength: 157 lbf (700 N); ASTM D 4632.
 - b. Sewn Seam Strength: 142 lbf (630 N); ASTM D 4632.
 - c. Tear Strength: 56 lbf (250 N); ASTM D 4533.
 - d. Puncture Strength: 56 lbf (250 N); ASTM D 4833.
 - 3. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
 - 4. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Survivability: As follows:
 - a. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
 - b. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
 - c. Tear Strength: 90 lbf (400 N); ASTM D 4533.
 - d. Puncture Strength: 90 lbf (400 N); ASTM D 4833.
 - 3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
 - 4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
1. Portland Cement: ASTM C 150/C 150M, Type I.
 2. Fly Ash: ASTM C 618, Class C or F.
 3. Normal-Weight Aggregate: ASTM C 33/C 33M, 3/4-inch (19-mm) nominal maximum aggregate size.
 4. Foaming Agent: ASTM C 869/C 869M.
 5. Water: ASTM C 94/C 94M.
- B. Produce low-density, controlled low-strength material with the following physical properties:
1. As-Cast Unit Weight: 30 to 36 lb/cu. ft. (480 to 576 kg/cu. m) at point of placement, when tested according to ASTM C 138/C 138M.
 2. Compressive Strength: 140 psi (965 kPa), when tested according to ASTM C 495/C 495M.

2.4 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Soils Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

- a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

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

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.
 1. Clearance: 12 inches (300 mm) each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.

3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches 6 inches (150 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.8 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.
1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

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

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring, bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 12 inches (300 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 6-inch- (150-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 6 inches (150 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Initial Backfill:
 - 1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

- a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
 2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.
- G. Final Backfill:
1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
 2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- H. Warning Tape: Install warning tape 12 inches (300 mm) directly above utilities.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
1. Under grass and planted areas, use satisfactory soil material.
 2. Under walks and pavements, use satisfactory soil material.
 3. Under steps and ramps, use engineered fill.
 4. Under building slabs, use engineered fill.
 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to between optimum and 4 percent above optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 4 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 9 inches (239 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 9 inches (229 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 9 inches (229 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
 - 2. Walks: Plus or minus 1 inch (25 mm).
 - 3. Pavements: Plus or minus 1/2 inch (13 mm).
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick.

Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice. The top 9" of pavement subgrade should consist of LVC material or chemically stabilized on-site soils.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place base course material over subbase course under hot-mix asphalt pavement.
 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
 5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 UNDER SLAB ON GRADE FLOORS

- A. Minimum 2-inch (50 mm) sand base over a minimum 12 inch (300 mm) LVC soil layer, except 18 inches (450 mm) at High School and Science Wing addition. LVC soils should be placed in 9-inch (229 mm) lifts.
- B. Moisture content of upper 9-inches (229 mm) of subgrade shall be checked prior to placement of the sand base. If subgrade is below optimum, subgrade shall be scarified, moisture conditioned, and recompacted prior to placement of sand base.
- C. Vapor Retarder: Install vapor retarder above granular course and beneath the slab-on-grade.

3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.21 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.22 PROTECTION

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

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

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SECTION 31 31 16 - TERMITE CONTROL**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. Soil treatment.
- B. Related Requirements:
 - 1. Section 06 10 00 "Rough Carpentry" for wood preservative treatment by pressure process.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
 - 2. Include the EPA-Registered Label for termiticide products.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.

6. Areas of application.
7. Water source for application.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.8 WARRANTY

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Bayer Environmental Science.
 - c. Ensysyex, Inc.
 - d. Syngenta.
2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
 3. Masonry: Treat voids.
 4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.5 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of termite-control-treatment Installer. Include quarterly maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
- B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 31 31 16